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A COMPENDIUM OF PORTAGE STUDIES

Samuel T. Brainerd

February 1982  
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U. S. ARMY HUMAN ENGINEERING LABORATORY  
Aberdeen Proving Ground, Maryland

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A COMPENDIUM OF PORTAGE STUDIES

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February 1982

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## A COMPENDIUM OF PORTAGE STUDIES

### BACKGROUND

Portability has long been recognized as an important facet of proper human engineering design of Army materiel; yet materiel acquisition documents seldom specify the distance over which an item must be carried, how it should be carried, or what organizational and operational considerations apply to the portage. Few designers, strategists, or human engineers are familiar with just how far and how fast soldiers can march with various loads. Appropriate data exist in profusion, but they are scattered throughout many journals and military reports. Furthermore, many studies have concentrated on specific pieces of equipment or carrying methods, discouraging any generalization of their results.

The need for the following compendium of portage studies was identified during the writing of a paper on the portability of an improved medium antiarmor assault weapon (95) that discussed the results of some 50 studies to show that the weapon was not too heavy for the mechanized infantry. Further research into other portage studies revealed that the data from most of them could be fitted into standardized charts to form a convenient and comprehensive reference on portability. Discussions with the development and user communities revealed that a reference that would facilitate portage research was needed.

### PURPOSE

The purpose of this compendium is to provide researchers in the fields of portage and marching with a comprehensive set of abstracted data from prior investigations. Using these abstracts, the researcher should be able to avoid needless testing and make valid recommendations about equipment weight and tactical use.

### METHODS

This compendium contains data from 86 studies culled from a larger number of studies reviewed. Studies were not included in the compendium if (1) their data could not be fitted to the standard format, (2) they contained no results (cf. survey reports), (3) they did not deal primarily with portage or marching, or (4) they were not available for review at press time. Section 2 of the References contains a list of those reports falling under categories 1 and 2 above, and Section 3 contains a list of the unavailable reports. Portability continues to be an important subject for study, so we hope to publish an addendum which will include future studies and many of the past reports that we have not yet obtained.

There have been a number of survey reports on portability in the past (87, 89, 107, 108, 112, 117, and 127), but the original data of the individual studies were not reproduced in a standard format. Instead, they presented summary recommendations; e.g., the "optimum load" should weigh no more than 35% of the porter's body weight. This compendium will not attempt to make such recommendations; rather, it will present the original data from each study in enough detail so that the conditions under which portability has been studied in the past can be easily reviewed.

Many future experiments on portage and marching studies could be avoided simply by using previous research. Field studies can be particularly expensive, and the cost is not always justified by the small gains in knowledge that the research produces.

Certain principles of load-carrying and marching are repeatedly emphasized by the data in this compendium: heavier loads result in slower marching speed or higher energy expenditure; faster speeds increase energy costs; grade and footing are important determiners of marching ease; and different carrying methods affect portability. Through the judicious use of these relationships, decisions about equipment design and tactics can be made without conducting an experiment.

The data from the 86 studies have been converted to a common set of units, greatly easing comparison of one study with another. For example, energy expenditure was reported in the studies with a bewildering variety of units: watts, joules, kilogram-calories (or kilocalories) per hour, kilocalories per minute, kilocalories per square meter of body surface, kilocalories per kilogram of body weight, gram-calories per horizontal kilogrammeter, and others. Using standard conversion factors (Table 1), all energy expenditures have been converted to watts.

The choice of units and portage variables was guided by the work of Dr. Ralph F. Goldman of the US Army Research Institute of Environmental Medicine. He, with others (57, 96), has developed a formula (1) for predicting metabolic energy expenditure while standing or walking with loads:

$$M = 1.5W + 2.0(W+L)(L/W)^2 + E(W+L)(1.5V^2 + 0.35VG) \quad (1)$$

where

- M = metabolic cost (watts)
- W = subject weight, nude (kg)
- L = external load (kg)
- E = footing factor
- V = velocity (m/sec)
- G = grade or slope (%)

While it may not always result in an accurate prediction, Formula 1 does incorporate more of the fundamental variables affecting portage and marching than any other available equation. Therefore, the tables have been arranged to feature the six variables and units specified by Formula 1.

TABLE 1  
Standard Conversion Factors<sup>a</sup>

Weight					
Pounds	x	0.4536	=		kilograms
Distance					
Miles	x	1.853	=		kilometers
Yards	x	0.9144	=		meters
Speed					
Meters/min	x	0.0167	=		meters/sec
Miles/hr	x	0.447	=		meters/sec
Km/hr	x	0.2778	=		meters/sec
Grade					
Degrees					
Energy					
Kcal/hr	x	1.1631	=		watts
Kcal/min	x	69.786	=		watts
KJ/min	x	14.334	=		Kcal/hr
Oxygen Use					
Cm <sup>3</sup>	x	0.001	=		liters
Temperature					
°F-32	x	0.5556	=		°C

<sup>a</sup>Body surface areas, body weights, and horizontal kilogrammeters taken from the means reported in individual studies.

The data from this compendium should be useful in certain pilot studies, but it should not be used for rigorous statistical purposes. The format itself guarantees that certain variables from past studies be given less attention than the six variables from Formula 1. These other variables are described as fully as possible, given the limited space, in the column headed "Test Condition/Method of Carry." Often it was impossible to keep within the compendium's format and still give the same emphasis to these variables as was given in the original reports.



A second limitation results from the rounding and estimation practiced in the compendium. All weights are specified only to the nearest kilogram; distances are reported to the nearest 10 meters; and, in general, only three significant digits are printed. This rounding was to make scanning the abstracts easier. Some of the data, moreover, had to be estimated so that Formula 1 could be applied. These estimations allow a great deal of inter-study comparisons, but they do prevent rigorous statistical use of the resulting data. The original reports should be read after using the compendium to narrow the choice of applicable studies.

The mechanics of abstracting each report were consistent and fairly simple. The data from each report were arranged by test condition and method of carry and converted to the appropriate units. Tabulated data from the reports were used whenever possible, although sometimes data points were estimated from graphs. Frequently, the weight of the subject's clothing, the grade of the marching course, and the type of footing had to be estimated from details in the text. In very few cases were the marching distances or the speed estimated, and then, only when the margin for error was sure to be small. Procedural notes applicable to each abstract are listed in footnotes.

#### USE OF THE COMPENDIUM

The most efficient use of this compendium requires the use of the indexes provided. Since the indexes are the best starting point, they are presented in front of the report summaries, rather than at the end.



## AUTHOR INDEX

The index lists every author, whether primary or secondary, of the 86 abstracted reports. The number or numbers to the right of the name represent the abstract number in the compendium. Thus, Bobbert, A.C. authored two reports, numbers 4 and 5. The reports are arranged numerically in the compendium section.

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## CATEGORY INDEX

The category index is presented in tabular form with the report number in the left-most column and the various categories to the right. There are seven categories: country, decade, study type, subjects, load location or carrying method, independent variables, and dependent variables.

The term 'country' is used loosely in this index to refer to the location of the laboratory that conducted the study. The information is of interest primarily because of the different traditions associated with each region in load-carrying research. Three 'countries' are listed: the United States (frequent site of field and treadmill studies using military subjects), the British Commonwealth (where studies of native load-bearers are common), and Other (a catch-all location for the few remaining studies).

'Decade' refers simply to the period during which the research was performed. Most of the research cited in the compendium took place in the last three decades.

'Study type' indicates whether the research was performed outdoors in a field experiment, indoors on a treadmill, indoors without a treadmill, or in some combination.

Four groups of subjects are listed under the heading 'Subjects.' Male subjects are divided into military and civilians. There have been few studies in which women carried the loads and only one involving children.

'Load Location or Carrying Method' distinguishes the methods of load-carrying. Different methods can have profoundly different effects on portability; compare, for instance, back packs with carts.

The independent variables used in each study are listed in the next set of columns. A scan of these columns reveals that many field studies control the load weight and distance, leaving marching speed as the dependent variable. Treadmill studies usually control the speed, weight, and distance, using physiological measures as dependent variables. Field studies, then, are often thought of as performance tests and treadmill studies physiological tests.

The final set of columns show the dependent variables in each study.



[illegible]

[illegible]



[illegible]

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## VARIABLE INDEX

It may be important to know not only which variables were used but also what levels of the variables were examined. The index to variables specifies what levels were chosen for any of six variables: load weight, load weight as a percentage of body weight, distance, speed, grade, and footing.

VARIABLE INDEX

Report No.	Total Load Weight (kg)						Load As Percent of Body Weight (%)										Distance (km)						Speed (mps)						Grade			Footing								
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+	0.0-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10.0	10.0-20.0	20.0+	0.00-0.99	1.00-1.49	1.50-1.99	2.00-2.99	3.00-3.99	4.00+	Net Level	Upgrade	Downgrade	Optimum	Degraded		
1	X										X											X					X		X											X
2	X								X																					X									X	
3	X								X																					X									X	
4	X								X																					X									X	
5	X								X																					X									X	
6									X																					X									X	
7									X																					X									X	
8	X								X																					X									X	
9									X																					X									X	
10									X																					X									X	
11									X																					X									X	
12									X																					X									X	
13									X																					X									X	
14									X																					X									X	
15	X								X																					X									X	
16	X								X																					X									X	
17	X								X																					X									X	
18	X								X																					X									X	
19	X								X																					X									X	
20	X								X																					X									X	
21	X								X																					X									X	
22								X																						X									X	
23																														X									X	
24																														X									X	
25																														X									X	
26	X																													X									X	
27																														X									X	
28																														X									X	
29																														X									X	
30	X																													X									X	



VARIABLE INDEX (Continued)

Report No.	Total Load Weight (kg)								Load As Percent of Body Weight (%)								Distance (km)								Speed (mps)						Grade			Footings							
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70+	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+	0.0-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10.0	10.0-20.0	20.0+	0.00-0.99	1.00-1.49	1.50-1.99	2.00-2.99	3.00-3.99	4.00+	Net Level	Upgrade	Downgrade	Optimum	Degraded			
31								X				X					X		X										X						X			X		X	
32												X																			X					X			X		
33						X										X																				X			X		
34	X	X							X		X									X														X						X	
35						X								X						X																X			X		
36	X	X			X	X			X			X		X						X															X			X		X	
37		X	X	X	X	X							X							X															X			X		X	
38			X	X									X							X																X					
39	X								X											X																X			X		
40	X								X											X																X			X		
41		X	X		X					X					X					X		X													X				X		X
42	X	X	X						X			X								X		X													X			X		X	
43	X								X											X																X			X		X
44	X								X											X																X			X		X
45	X	X			X			X												X																X			X		X
46	X	X	X						X					X						X																X			X		X
47	X								X											X																X			X		X
48	X								X											X																X			X		X
49	X								X											X																X			X		X
50	X								X											X																X			X		X
51	X			X					X		X	X	X							X		X													X			X		X	
52	X			X					X						X					X															X			X		X	
53	X								X											X																X			X		X
54			X							X		X								X																X			X		X
55	X							X	X											X																X			X		X
56	X	X							X											X																X			X		X
57	X	X		X					X	X			X	X						X															X			X		X	
58	X																			X																X			X		X
59				X								X	X	X						X															X			X		X	
60		X										X	X	X						X															X			X		X	

VARIABLE INDEX (Continued)

Report No.	Total Load Weight (kg)						Load As Percent of Body Weight (%)										Distance (km)						Speed (mps)						Grade		Footing		
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+	0.0-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-10.0	10.0-20.0	20.0+	0.00-0.99	1.00-1.49	1.50-1.99	2.00-2.99	3.00-3.99	4.00+	Net Level	Upgrade	Downgrade	Optimum	Degraded			
61	X	X	X	X								X	X	X						X	X						X			X			
62	X		X		X							X	X							X							X			X			
63	X											X								X		X					X			X			
64	X	X		X								X					X			X	X	X					X			X			
65	X		X																														
66	X							X				X								X	X								X				
67					X			X				X									X	X								X			
68	X	X		X										X						X	X	X					X			X			
69	X	X		X										X						X	X	X					X			X			
70		X		X												X					X	X					X			X			
71	X			X						X		X	X	X	X					X	X	X					X			X			
72		X								X						X						X					X			X			
73	X	X								X						X								X			X				X		
74	X	X								X															X		X						
75	X	X										X										X					X				X		
76		X	X																				X				X						
77		X	X															X															
78	X	X	X							X												X					X				X		
79	X	X	X							X												X	X				X				X		
80	X	X	X					X		X		X	X	X							X	X	X	X	X		X						
81		X										X		X	X						X	X						X					
82		X	X							X		X	X	X	X						X	X	X	X			X						
83	X	X	X							X																	X				X		
84														X								X					X				X		
85	X		X									X			X						X	X	X	X			X			X			
86	X											X	X							X	X	X	X				X				X		

(Concluded)

## EXAMPLE OF INDEX USE

Suppose one were interested in conducting a field study on the portability of a weapon system weighing 35 kg that must be portable for up to 5 km. Have any studies been conducted that were similar and could be used to predict the results of the proposed research?

The first step would be to check the Index to Variables under total load weights of 30 to 39 kg. This category is a large one, with 24 of the 86 studies involving loads in that range. Only nine of those 24 studies, though, also involved distances of, say, 3 km or more: studies 11, 29, 36, 38, 52, 59, 64, 70, and 84. The index of categories shows which of those nine studies were field studies: 38, 52, 59, and 64. Abstracts of these four studies can be found, in numerical order, in the compendium section where the field of inquiry might be further narrowed. It may happen that new research is not needed because it has been adequately covered by older research. If new research is still needed, it may be that the older studies can alert the experimenters to possible pitfalls. Be aware, however, that the abstract is no substitute for a careful reading of the original report.

## REPORT SUMMARIES:

Descriptions of each heading in the report summaries follow:

### Date

The date shown is the date of publication or, if known, the date of submission for publication.

### Title

In order to save space, the full title of each report is not always given. See Part 1 of the Bibliography for the complete title.

### Author(s)

Only the authors' surnames are given.

### Laboratory

The laboratory sponsor or the research organization is listed.

### Type

Three types of study are recognized:

- (1) Treadmill - the subjects walk or run on a treadmill.
- (2) Field - the subjects walk or run outdoors.
- (3) Laboratory - the subject walk or run indoors.



## Subjects

The number and type of subjects are given.

## Test Condition/Method of Carry

As many details are given as possible in the small space to identify the method used to carry the load and any other identifiers of the test condition. The original wording of the report is often used, as are the original units of measurement. The units are converted to the standard units in the data columns.

## Subjects/No.

This column contains the number of subjects participating in each particular test condition. This number is likely to differ from the total number of subjects shown in the heading because experimenters commonly design experiments in which different subjects are tested under different conditions.

## Subjects/W(kg)

The column contains the mean weight in kilograms of the subjects used in each test condition.

## Weight (kg)/Unif.

This column lists the weight of the subject's uniform, in kilograms, for each condition. Depending on the study, the uniform can consist of as little as a breechcloth and sandals or as much as a full set of Army fatigues and an armored vest. The common denominator is that the items that make up the uniform remain essentially the same throughout the experiment. Any part of the clothing that is varied systematically during a study is considered part of the subject's load. For many of the 86 reports the weight of the uniform has been estimated from details in the text.

## Weight (kg)/Load

This column lists the weight, in kilograms, of the part of the subject's load is varied systematically. Usually, the load consists of a backpack or some piece of equipment, but variations in what normally would be considered part of the subject's clothing can be considered part of the load.

## % BW

The column contains the total weight, uniform and load, borne by the subjects, expressed as a percentage of the subjects' mean body weight, for each condition.

#### Dist (km)

The distance that the subjects walked or ran for each test condition is given. If this distance was an independent variable in the experiment, the number is underlined. The underline is omitted when distance was a dependent variable or was uncontrolled.

#### Speed (mps)

The speed, in meters per second, at which the subjects walked or ran for each condition is specified in this column. As with the distance, the speed is underlined if it was an independent variable.

#### Grade (%)

The slope or grade of the course traversed by the subjects for each condition is expressed as a percentage of vertical climb over horizontal travel. In most cases in which a grade other than 0% is recorded, the amount of grade was under experimental control. Usually when the grade was not controlled, there were both uphill and downhill, and the assigned value is 0%.

#### Footing Factor

The footing factor is a variable first employed by Goldman who called it the terrain factor (57, 96). In his studies, Goldman has empirically assigned values to various footing conditions for use in Formula 1:

- 1.0 blacktop or treadmill
- 1.1 dirt road
- 1.2 light brush
- 1.3 hard-packed snow
- 1.5 heavy brush
- 1.8 swampy bog
- 2.1 loose sand
- 2.5 soft snow (15 cm penetration)
- 3.3 soft snow (25 cm penetration)
- 4.1 soft snow (35 cm penetration)

In this compendium, other factors are occasionally used as well to estimate mean values for varied footing.

#### Energy (Watts)/Obs.

This column contains the mean metabolic energy expenditure, in watts, measured during the study for each condition. Although a variety of measures have been used to calculate energy expenditure over the years, no description of the method used will be made, since the results are equivalent.

Several attempts have been made to give levels of energy expenditure that can be used in a practical way. Christensen (reported in 116) has developed the following definitions of different work levels:



Unduly heavy work = over 872 watts  
Very heavy work = 698 to 872 watts  
Heavy work = 523 to 698 watts  
Moderate work = 349 to 523 watts  
Light work = 174 to 349 watts  
Very light work = under 174 watts

Goldman (100) has also presented some guidelines for energy cost:

Comfort = 116 watts  
Discomfort = over 349 watts  
Exceeds voluntary hard work level = over 494 watts  
Damage = over 1,047 watts  
Exceeds maximum work capacity = over 1,186 watts

Goldman further expresses some tolerance limits related to duration of energy expense:

Work endurance difficult beyond 15 minutes: 837 to 1,047 watts  
Work endurance difficult beyond 1 hour: 698 watts  
Work endurance difficult beyond 2 to 3 hours: 488 to 558 watts  
Work endurance difficult beyond 8 hours: 349 to 419 watts

These figures are but guidelines and apply particularly to average subjects under average, steady-state conditions. Well-conditioned athletes can endure such expenditures longer, and under-trained subjects can produce higher expenditures for very short durations.

#### Energy (Watts)/Pred.

The amount of energy expended during load-carrying or simple marching can be predicted by Formula 1. A column has been provided in this compendium for the predicted energy cost so it can be compared to the measured cost.

#### Heart Rate

This column contains the mean number of heart beats per minute for the subjects under each condition.

#### VO<sub>2</sub> (L/min)

This column contains the mean amount of oxygen consumed, in liters per minute, for each condition. In most cases the exhaled gasses were collected after the subjects had been exercising for several minutes, so their consumption was steady. Oxygen use is related to total energy expenditure, but it is a less comprehensive figure.

### Other (Specified)

Some studies have reported other dependent variables than the ones listed above:

1. Forward body lean, in degrees from vertical.
2. Sweat loss, in grams per 30 minutes.
3. Rectal or core temperature, in degrees Celsius.
4. Pulmonary ventilation, in liters per minute.
5. Step frequency, in strides per minute.
6. White blood cell count, ratio or post- to pre-exercise.
7. Mean blood pressure, estimated.
8. Mechanical energy expenditure, in watts.
9. Perceived exertion, subjective scale.
10. Subjects failing to complete the task, in percent.
11. Stride length, in centimeters.

## Report 1

Date : 1944, May  
 Title : Study of schedules, duration and difficulty of rest periods...on long marches  
 Author(s): Ashe, Ress, and Glenney  
 Lab : Armored Medical Research Laboratory  
 Type : Field  
 Subjects : 38 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	20 lb pack - 79 miles in 6 days- enforced pace	12 <sup>b</sup>	73 <sup>c</sup>	7 <sup>d</sup>	9	22
2	20 lb pack - 79 miles in 6 days- self paced	12 <sup>b</sup>	73 <sup>c</sup>	7 <sup>d</sup>	9	22
3	20 lb pack - 125 miles in 5 days- self paced	12 <sup>b</sup>	73 <sup>c</sup>	7 <sup>d</sup>	9	22

<sup>a</sup>Data not collected.

<sup>b</sup>Most subjects completed all marches (mean of 120 miles for all subjects on 5 day march).

<sup>c</sup>Mean weight for original pool of 38 subjects.

<sup>d</sup>Estimated from textual details.

<sup>e</sup>Maximum, single - day distance.

<sup>f</sup>Maximum pace for an entire march.

<sup>g</sup>Grade assumed to 0%.

## Report 2

Date : 1960  
 Title : A pilot study of work on a treadmill in women 20 - 65 years old  
 Author(s): Åstrand  
 Lab : Kungl. Gymnastiska Centralinstitutet, Sweden  
 Type : Treadmill  
 Subjects : 42 women

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Age 20 - 29	7	56	2 <sup>b</sup>	0	4
2	Age 30 - 39	11	58	2 <sup>b</sup>	0	3
3	Age 40 - 49	8	62	2 <sup>b</sup>	0	3
4	Age 50 - 65	16	65	2 <sup>b</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.

# Report 1

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>30.58</u> <sup>e</sup>	<u>1.34</u>	a	1.1	a	382 <sup>g</sup>	a	a
2	<u>30.58</u> <sup>e</sup>	<u>1.43</u> <sup>f</sup>	a	1.1	a	418 <sup>g</sup>	a	a
3	<u>40.23</u> <sup>e</sup>	<u>1.43</u> <sup>f</sup>	a	1.2	a	446 <sup>g</sup>	a	a

# Report 2

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent.
					Obs.	Pred.			(L/Min)
1	1.00	1.39	0	1.0	a	252	111	0.85	20.8
2	1.00	1.39	0	1.0	a	261	112	0.89	22.9
3	1.00	1.39	0	1.0	a	279	117	1.08	27.4
4	1.00	1.39	0	1.0	a	292	108	1.01	24.9

### Report 3

Date : 1915  
 Title : Energy transformation during horizontal walking  
 Author(s): Benedict and Murchhauser  
 Lab : Not given  
 Type : Not given  
 Subjects : Not given

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	3 kg load - 0.79 mps	a	61 <sup>b</sup>	3	0	5
2	" - 1.19 mps	a	61 <sup>b</sup>	3	0	5
3	" - 1.52 mps	a	61 <sup>b</sup>	3	0	5
4	" - 1.91 mps	a	61 <sup>b</sup>	3	0	5
5	" - 2.35 mps	a	61 <sup>b</sup>	3	0	5
6	14 kg load - 0.79 mps	a	61 <sup>b</sup>	3	11	23
7	" - 1.19 mps	a	61 <sup>b</sup>	3	11	23
8	" - 1.52 mps	a	61 <sup>b</sup>	3	11	23
9	" - 1.91 mps	a	61 <sup>b</sup>	3	11	23
10	24 kg load - 0.79 mps	a	61 <sup>b</sup>	3	21	39
11	" - 1.19 mps	a	61 <sup>b</sup>	3	21	39
12	" - 1.52 mps	a	61 <sup>b</sup>	3	21	39
13	" - 1.91 mps	a	61 <sup>b</sup>	3	21	39
14	36 kg load - 0.79 mps	a	61 <sup>b</sup>	3	33	59
15	" - 1.19 mps	a	61 <sup>b</sup>	3	33	59
16	" - 1.52 mps	a	61 <sup>b</sup>	3	33	59
17	" - 1.91 mps	a	61 <sup>b</sup>	3	33	59
18	46 kg load - 0.72 mps	a	61 <sup>b</sup>	3	43	75
19	" - 1.19 mps	a	61 <sup>b</sup>	3	43	75
20	" - 1.52 mps	a	61 <sup>b</sup>	3	43	75
21	56 kg load - 0.72 mps	a	61 <sup>b</sup>	3	53	91
22	" - 1.19 mps	a	61 <sup>b</sup>	3	53	91
23	" - 1.52 mps	a	61 <sup>b</sup>	3	53	91

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated to allow conversion from gram calories/kg·m to Watts (based on data used in Ref. 11).

Note: Data taken from Ref. 11.



### Report 3

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	a	0.79	0	1.0	102	152	a	a
2	a	1.19	0	1.0	191	228	a	a
3	a	1.52	0	1.0	232	314	a	a
4	a	1.91	0	1.0	396	442	a	a
5	a	2.35	0	1.0	588	622	a	a
6	a	0.79	0	1.0	119	170	a	a
7	a	1.19	0	1.0	175	259	a	a
8	a	1.52	0	1.0	296	359	a	a
9	a	1.91	0	1.0	560	510	a	a
10	a	0.79	0	1.0	160	197	a	a
11	a	1.19	0	1.0	220	298	a	a
12	a	1.52	0	1.0	319	412	a	a
13	a	1.91	0	1.0	621	583	a	a
14	a	0.79	0	1.0	189	250	a	a
15	a	1.19	0	1.0	256	365	a	a
16	a	1.52	0	1.0	395	495	a	a
17	a	1.91	0	1.0	709	690	a	a
18	a	0.79	0	1.0	205	313	a	a
19	a	1.19	0	1.0	298	440	a	a
20	a	1.52	0	1.0	551	584	a	a
21	a	0.79	0	1.0	228	398	a	a
22	a	1.19	0	1.0	343	537	a	a
23	a	1.52	0	1.0	573	694	a	a

# Report 4

Date : 1959, September  
 Title : Physiological comparison of three types of ergometry  
 Author(s): Bobbert  
 Lab : Netherlands Institute for Preventive Medicine  
 Type : Treadmill  
 Subjects : 6 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	39m/min - 5° slope	6	81	2 <sup>b</sup>	0	2
2	" - 10° slope	6	81	2 <sup>b</sup>	0	2
3	54m/min - 0° slope	6	81	2 <sup>b</sup>	0	2
4	" - 5° slope	6	81	2 <sup>b</sup>	0	2
5	" - 10° slope	6	81	2 <sup>b</sup>	0	2
6	" - 15° slope	6	81	2 <sup>b</sup>	0	2
7	69m/min - 0° slope	6	81	2 <sup>b</sup>	0	2
8	" - 5° slope	6	81	2 <sup>b</sup>	0	2
9	" - 10° slope	6	81	2 <sup>b</sup>	0	2
10	93m/min - 5° slope	6	81	2 <sup>b</sup>	0	2
11	108m/min - 0° slope	6	81	2 <sup>b</sup>	0	2
12	" - 5° slope	6	81	2 <sup>b</sup>	0	2

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.

# Report 4

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	a	<u>0.65</u>	8.8	1.0	359	340	a	a
2	a	<u>0.65</u>	17.6	1.0	518	507	a	a
3	a	<u>0.90</u>	0.0	1.0	272	222	a	a
4	a	<u>0.90</u>	8.8	1.0	475	453	a	a
5	a	<u>0.90</u>	17.6	1.0	716	683	a	a
6	a	<u>0.90</u>	26.8	1.0	978	923	a	a
7	a	<u>1.15</u>	0.0	1.0	310	286	a	a
8	a	<u>1.15</u>	8.8	1.0	529	580	a	a
9	a	<u>1.15</u>	17.6	1.0	830	874	a	a
10	a	<u>1.55</u>	8.8	1.0	750	817	a	a
11	a	<u>1.80</u>	0.0	1.0	507	525	a	a
12	a	<u>1.80</u>	8.8	1.0	962	985	a	a

# Report 5

Date : 1959, September  
 Title : Energy expenditure in level and grade walking  
 Author(s): Bobbert  
 Lab : Netherlands Institute for Preventive Medicine  
 Type : Treadmill  
 Subjects : 2 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	36 mpm - 0° gradient	2	79	b	0	a
2	" - 4° gradient	2	79	b	0	a
3	" - 8° gradient	2	79	b	0	a
4	" - 12° gradient	2	79	b	0	a
5	51 mpm - 0° gradient	2	79	b	0	a
6	" - 4° gradient	2	79	b	0	a
7	" - 8° gradient	2	79	b	0	a
8	" - 12° gradient	2	79	b	0	a
9	66 mpm - 0° gradient	2	79	b	0	a
10	" - 4° gradient	2	79	b	0	a
11	" - 8° gradient	2	79	b	0	a
12	" - 12° gradient	2	79	b	0	a
13	81 mpm - 0° gradient	2	79	b	0	a
14	" - 4° gradient	2	79	b	0	a
15	" - 8° gradient	2	79	b	0	a
16	" - 12° gradient	2	79	b	0	a
17	96 mpm - 0° gradient	2	79	b	0	a
18	" - 4° gradient	2	79	b	0	a
19	" - 8° gradient	2	79	b	0	a
20	111 mpm - 0° gradient	2	79	b	0	a
21	" - 4° gradient	2	79	b	0	a
22	45 mpm - 0° gradient	1	75	b	0	a
23	" - 1° gradient	1	75	b	0	a
24	" - 2° gradient	1	75	b	0	a
25	" - 3° gradient	1	75	b	0	a
26	" - 4° gradient	1	75	b	0	a
27	" - 5° gradient	1	75	b	0	a
28	" - 6° gradient	1	75	b	0	a
29	" - 8° gradient	1	75	b	0	a
30	" - 10° gradient	1	75	b	0	a
31	" - 12° gradient	1	75	b	0	a
32	69 mpm - 0° gradient	1	75	b	0	a
33	" - 1° gradient	1	75	b	0	a
34	" - 2° gradient	1	75	b	0	a
35	" - 3° gradient	1	75	b	0	a
36	" - 4° gradient	1	75	b	0	a



# Report 5

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Strides Per min.
					Obs.	Pred.			
1	0.36	0.60	0	1.0	219	157 <sup>c</sup>	a	a	66
2	0.36	0.60	7	1.0	296	273 <sup>c</sup>	a	a	63
3	0.36	0.60	14.1	1.0	438	391 <sup>c</sup>	a	a	64
4	0.36	0.60	21.3	1.0	537	510 <sup>c</sup>	a	a	64
5	0.51	0.85	0	1.0	247	200 <sup>c</sup>	a	a	84
6	0.51	0.85	7	1.0	364	364 <sup>c</sup>	a	a	78
7	0.51	0.85	14.1	1.0	518	531 <sup>c</sup>	a	a	82
8	0.51	0.85	21.3	1.0	709	700 <sup>c</sup>	a	a	79
9	0.66	1.10	0	1.0	285	258 <sup>c</sup>	a	a	101
10	0.66	1.10	7	1.0	438	471 <sup>c</sup>	a	a	94
11	0.66	1.10	14.1	1.0	655	686 <sup>c</sup>	a	a	94
12	0.66	1.10	21.3	1.0	904	905 <sup>c</sup>	a	a	97
13	0.81	1.35	0	1.0	348	330 <sup>c</sup>	a	a	108
14	0.81	1.35	7	1.0	542	592 <sup>c</sup>	a	a	103
15	0.81	1.35	14.1	1.0	819	857 <sup>c</sup>	a	a	108
16	0.81	1.35	21.3	1.0	1153	1125 <sup>c</sup>	a	a	113
17	0.96	1.60	0	1.0	403	418 <sup>c</sup>	a	a	117
18	0.96	1.60	7	1.0	663	727 <sup>c</sup>	a	a	114
19	0.96	1.60	14.1	1.0	1003	1041 <sup>c</sup>	a	a	122
20	1.11	1.85	0	1.0	499	520 <sup>c</sup>	a	a	125
21	1.11	1.85	7	1.0	822	878 <sup>c</sup>	a	a	128
22	0.45	0.75	0	1.0	224	172 <sup>c</sup>	a	a	a
23	0.45	0.75	1.8	1.0	239	207 <sup>c</sup>	a	a	a
24	0.45	0.75	3.5	1.0	255	240 <sup>c</sup>	a	a	a
25	0.45	0.75	5.3	1.0	291	276 <sup>c</sup>	a	a	a
26	0.45	0.75	7.0	1.0	312	309 <sup>c</sup>	a	a	a
27	0.45	0.75	8.8	1.0	354	345 <sup>c</sup>	a	a	a
28	0.45	0.75	10.5	1.0	380	378 <sup>c</sup>	a	a	a
29	0.45	0.75	14.1	1.0	458	449 <sup>c</sup>	a	a	a
30	0.45	0.75	17.6	1.0	530	518 <sup>c</sup>	a	a	a
31	0.45	0.75	21.3	1.0	603	591 <sup>c</sup>	a	a	a
32	0.69	1.15	0	1.0	265	257 <sup>c</sup>	a	a	a
33	0.69	1.15	1.8	1.0	307	311 <sup>c</sup>	a	a	a
34	0.69	1.15	3.5	1.0	338	363 <sup>c</sup>	a	a	a
35	0.69	1.15	5.3	1.0	380	417 <sup>c</sup>	a	a	a
36	0.69	1.15	7	1.0	442	468 <sup>c</sup>	a	a	a

[continued]

Report 5 [continued]

Date : 1959, September  
 Title : Energy expenditure in level and grade walking  
 Author(s): Bobbert  
 Lab : Netherlands Institute for Preventive Medicine  
 Type : Treadmill  
 Subjects : 2 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
37	69 mpm - 6° gradient	1	75	b	0	a
38	" - 8° gradient	1	75	b	0	a
39	" - 10° gradient	1	75	b	0	a
40	" - 12° gradient	1	75	b	0	a
41	90 mpm - 0° gradient	1	75	b	0	a
42	" - 1° gradient	1	75	b	0	a
43	" - 3° gradient	1	75	b	0	a
44	" - 4° gradient	1	75	b	0	a
45	" - 6° gradient	1	75	b	0	a
46	" - 8° gradient	1	75	b	0	a

<sup>a</sup>Data not collected.

<sup>b</sup>Weight of clothes and shoes included in body weight.

<sup>c</sup>Clothing weight of 3kg assumed.

# Report 5

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>	<u>Strides Per min.</u>
					<u>Obs.</u>	<u>Pred.</u>			
37	<u>0.69</u>	<u>1.15</u>	10.5	1.0	551	574 <sup>c</sup>	a	a	a
38	<u>0.69</u>	<u>1.15</u>	14.1	1.0	650	683 <sup>c</sup>	a	a	a
39	<u>0.69</u>	<u>1.15</u>	17.6	1.0	764	788 <sup>c</sup>	a	a	a
40	<u>0.69</u>	<u>1.15</u>	21.3	1.0	899	900 <sup>c</sup>	a	a	a
41	<u>0.90</u>	<u>1.50</u>	0	1.0	359	361 <sup>c</sup>	a	a	a
42	<u>0.90</u>	<u>1.50</u>	3.5	1.0	442	499 <sup>c</sup>	a	a	a
43	<u>0.90</u>	<u>1.50</u>	5.3	1.0	510	570 <sup>c</sup>	a	a	a
44	<u>0.90</u>	<u>1.50</u>	7	1.0	577	637 <sup>c</sup>	a	a	a
45	<u>0.90</u>	<u>1.50</u>	10.5	1.0	728	775 <sup>c</sup>	a	a	a
46	<u>0.90</u>	<u>1.50</u>	14.1	1.0	889	917 <sup>c</sup>	a	a	a

[concluded]

# Report 6

Date : 1981  
 Title : Analysis of the USAIS IMAAWS portability demonstration  
 Author(s): Brainerd  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 10 airborne soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	10 km march - 25 lb IMAAWS	5	81	5	36	51
2	" - 35 lb IMAAWS	5	73	5	41	63
3	" - 45 lb IMAAWS	5	70	5	45	71
4	3.5 km march - 25 lb IMAAWS	5	81	5	24	35
5	" - 35 lb IMAAWS	5	73	5	28	45
6	" - 45 lb IMAAWS	5	70	5	33	54
7	400 m run - 25 lb IMAAWS	5	81	5	24	35
8	" - 35 lb IMAAWS	5	73	5	28	45
9	" - 45 lb IMAAWS	5	70	5	33	54
10	50 m run - 25 lb IMAAWS	5	81	5	24	35
11	" - 35 lb IMAAWS	5	73	5	28	45
12	" - 45 lb IMAAWS	5	70	5	33	54

<sup>a</sup>Data not collected.



# Report 6

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	10.00	1.59	0	1.1	a	693	124	a
2	10.00	1.36	0	1.1	a	567	114	a
3	10.00	1.54	0	1.1	a	697	122	a
4	3.50	1.76	0	1.1	a	712	117	a
5	3.50	1.61	0	1.1	a	606	111	a
6	3.50	1.73	0	1.1	a	702	119	a
7	0.40	3.26	0	1.1	a	2079	a	a
8	0.40	2.04	0	1.1	a	881	a	a
9	0.40	2.46	0	1.1	a	1247	a	a
10	0.05	3.92	0	1.1	a	2939	a	a
11	0.05	3.45	0	1.1	a	2235	a	a
12	0.05	3.57	0	1.1	a	2440	a	a

# Report 7

Date : 1981  
 Title : Medium antitank weapon portability for the mechanized infantry  
 Author(s): Brainerd and Giordano  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 20 male marines

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	20	72	18	0	25
2	Two Dragon rounds - slung	5	71	18	23	58
3	Dragon round, sight, and tripod - pack, slung	5	71	18	31	69
4	Dragon round and tripod - pack	5	77	18	20	49
5	Dragon round and sight - pack	5	70	18	24	60
6	Two Dragon rounds - slung	20	72	18	23	57
7	Dragon round, sight, and tripod - pack, slung	20	72	18	31	68
8	Dragon round and tripod - pack	20	72	18	20	53
9	Dragon round and sight - pack	20	72	18	24	58
10	Two TOW rounds - litter carry	20	72	18	25 <sup>b</sup>	60
11	Lightweight TOW - litter carry	20	72	18	33 <sup>b</sup>	71
12	Two Dragon rounds - slung	20	72	18	23	57
13	Dragon round, sight, and tripod - pack, slung	20	72	18	31	68
14	Dragon round and tripod	20	72	18	20	53
15	Dragon round and sight	20	72	18	24	58
16	Two TOW rounds - litter carry	20	72	18	25 <sup>b</sup>	60
17	Lightweight TOW - litter carry	20	72	18	33 <sup>b</sup>	71
18	Lightweight TOW - litter with straps	16	72	18	33 <sup>b</sup>	71
19	Dragon round, sight, and tripod - pack, slung	4	67	18	31	73
20	Lightweight TOW round and yoke - pack	20	72	18	34	72
21	Lightweight TOW tube and tripod - pack, slung	20	72	18	31	68

<sup>a</sup>Data not collected.

<sup>b</sup>Litter weight divided by two.

<sup>c</sup>Average grade ranged from - 13% to + 16%.

# Report 7

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>0.60</u>	3.56	0 <sup>c</sup>	1.1	a	2001	a	a
2	<u>0.60</u>	2.43	0 <sup>c</sup>	1.1	a	1272	a	a
3	<u>0.60</u>	2.27	0 <sup>c</sup>	1.1	a	1241	a	a
4	<u>0.60</u>	2.74	0 <sup>c</sup>	1.1	a	1596	a	a
5	<u>0.60</u>	2.50	0 <sup>c</sup>	1.1	a	1341	a	a
6	<u>0.30</u>	2.32	11	1.1	a	2295	a	a
7	<u>0.30</u>	2.12	11	1.1	a	2204	a	a
8	<u>0.30</u>	2.45	11	1.1	a	2648	a	a
9	<u>0.30</u>	2.33	11	1.1	a	2332	a	a
10	<u>0.30</u>	2.00	11	1.1	a	1923	a	a
11	<u>0.30</u>	1.72	11	1.1	a	1728	a	a
12	<u>0.15</u>	2.60	16	1.1	a	3251	a	a
13	<u>0.15</u>	2.37	16	1.1	a	3108	a	a
14	<u>0.15</u>	2.79	16	1.1	a	3473	a	a
15	<u>0.15</u>	2.61	16	1.1	a	3300	a	a
16	<u>0.15</u>	2.19	16	1.1	a	2651	a	a
17	<u>0.15</u>	1.91	16	1.1	a	2191	a	a
18	<u>0.15</u>	2.09	16	1.1	a	2701	a	a
19	0.15	2.07	16	1.1	a	2524	a	a
20	<u>0.15</u>	2.21	16	1.1	a	2925	a	a
21	<u>0.15</u>	2.18	16	1.1	a	2794	a	a

## Report 8

Date : 1963  
 Title : Discrepancy between heart rate and oxygen consumption during work in the warmth  
 Author(s): Brouha, Maxfield, Smith, and Stopps  
 Lab : Haskell Laboratory for Toxicology and Industrial Medicine  
 Type : Treadmill  
 Subjects : 4 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Light thermal stress (90°F, 22% RH)	4	85	2 <sup>b</sup>	0	2
2	Severe thermal stress (105°F, 63% RH)	4	85	2 <sup>b</sup>	0	2
3	Severe work stress (70°F, 43% RH)	4	85	2 <sup>b</sup>	0	2

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.

## Report 9

Date : 1963, February  
 Title : Human factors evaluation of Bell Aerosystem's "Hip Pack"  
 Author(s): Carlock and Weasner  
 Lab : Engineering Sciences Laboratory  
 Type : Field  
 Subjects : 16 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Packboard	8	75 <sup>b</sup>	6 <sup>c</sup>	41	63
2	Hip Pack	8	75 <sup>b</sup>	6 <sup>c</sup>	41	63
3	Free-hand litter	8	75 <sup>b</sup>	6 <sup>c</sup>	43 <sup>e</sup>	65
4	Hip Pack litter	8	75 <sup>b</sup>	6 <sup>c</sup>	45 <sup>e</sup>	68

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for all 16 subjects.

<sup>c</sup>Estimated from textual details.

<sup>d</sup>Includes adjustments for hand-carried loads:  $0.014(\text{Load Wgt})^2(\text{Speed})^2$ .

<sup>e</sup>Load weight per carrier.



# Report 8

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>2.15</u>	<u>1.43</u>	0	1.0	a	394	106	1.06
2	<u>2.15</u>	<u>1.43</u>	0	1.0	a	394	138	1.01
3	<u>2.15</u>	<u>1.43</u>	10	1.0	a	830	142	2.51

# Report 9

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>3.22</u>	1.22	0	1.5	a	617	a	a
2	<u>3.22</u>	1.29	0	1.5	a	665 <sup>d</sup>	a	a
3	<u>3.22</u>	0.38	0	1.5	a	264 <sup>d</sup>	a	a
4	<u>3.22</u>	0.65	0	1.5	a	364 <sup>d</sup>	a	a

# Report 10

Date : 1919  
 Title : Energy expenditure of the infantry recruit in training  
 Author(s): Cathcart and Orr  
 Lab : Not given  
 Type : Field and Laboratory  
 Subjects : 9 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Field - drill order load	8	62	b	15	25
2	" - fighting order load	8	62	b	21	33
3	" - marching order load	8	62	b	25	40
4	Lab - 11 kg load - 0.95 mps	1	63	b	11	18
5	" - " - 1.22 mps	1	63	b	11	18
6	" - " - 1.52 mps	1	63	b	11	18
7	" - " - 1.68 mps	1	63	b	11	18
8	" - " - 1.83 mps	1	63	b	11	18
9	" - " - 3.05 mps	1	63	b	11	18
10	" - 16 kg load - 0.95 mps	1	63	b	16	26
11	" - " - 1.22 mps	1	63	b	16	26
12	" - " - 1.52 mps	1	63	b	16	26
13	" - " - 1.68 mps	1	63	b	16	26
14	" - " - 1.83 mps	1	63	b	16	26
15	" - " - 2.44 mps	1	63	b	16	26
16	" - " - 3.05 mps	1	63	b	16	26
17	" - 21 kg load - 0.95 mps	1	63	b	21	34
18	" - " - 1.22 mps	1	63	b	21	34
19	" - " - 1.52 mps	1	63	b	21	34
20	" - " - 1.68 mps	1	63	b	21	34
21	" - " - 1.83 mps	1	63	b	21	34
22	" - " - 2.44 mps	1	63	b	21	34
23	" - " - 3.05 mps	1	63	b	21	34
24	" - 26 kg load - 0.95 mps	1	63	b	26	42
25	" - " - 1.22 mps	1	63	b	26	42
26	" - " - 1.52 mps	1	63	b	26	42
27	" - " - 1.68 mps	1	63	b	26	42
28	" - " - 1.83 mps	1	63	b	26	42
29	" - 9 kg load - 0.92 mps	3	64	b	9	14
30	" - " - 1.37 mps	3	64	b	9	14
31	" - " - 1.83 mps	3	64	b	9	14
32	" - 26 kg load - 0.92 mps	3	64	b	26	41
33	" - " - 1.37 mps	3	64	b	26	41
34	" - " - 1.83 mps	3	64	b	26	41

<sup>a</sup>Data not collected.

<sup>b</sup>Weight included under load weight.

Note: Data taken from Ref. 11.

# Report 10

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	a	<u>1.52</u>	0	1.0	268	369	a	a
2	a	<u>1.52</u>	0	1.0	336	400	a	a
3	a	<u>1.52</u>	0	1.0	373	423	a	a
4	a	<u>0.95</u>	0	1.0	153	199	a	a
5	a	<u>1.22</u>	0	1.0	210	264	a	a
6	a	<u>1.52</u>	0	1.0	282	355	a	a
7	a	<u>1.68</u>	0	1.0	341	412	a	a
8	a	<u>1.83</u>	0	1.0	389	471	a	a
9	a	<u>3.05</u>	0	1.0	798	1132	a	a
10	a	<u>0.95</u>	0	1.0	141	212	a	a
11	a	<u>1.22</u>	0	1.0	205	281	a	a
12	a	<u>1.52</u>	0	1.0	306	378	a	a
13	a	<u>1.68</u>	0	1.0	359	439	a	a
14	a	<u>1.83</u>	0	1.0	427	502	a	a
15	a	<u>2.44</u>	0	1.0	674	810	a	a
16	a	<u>3.05</u>	0	1.0	812	1207	a	a
17	a	<u>0.95</u>	0	1.0	163	227	a	a
18	a	<u>1.22</u>	0	1.0	243	301	a	a
19	a	<u>1.52</u>	0	1.0	320	404	a	a
20	a	<u>1.68</u>	0	1.0	382	469	a	a
21	a	<u>1.83</u>	0	1.0	454	535	a	a
22	a	<u>2.44</u>	0	1.0	760	863	a	a
23	a	<u>3.05</u>	0	1.0	886	1285	a	a
24	a	<u>0.95</u>	0	1.0	170	245	a	a
25	a	<u>1.22</u>	0	1.0	249	324	a	a
26	a	<u>1.52</u>	0	1.0	356	433	a	a
27	a	<u>1.68</u>	0	1.0	436	502	a	a
28	a	<u>1.83</u>	0	1.0	488	572	a	a
29	a	<u>0.92</u>	0	1.0	134	192	a	a
30	a	<u>1.37</u>	0	1.0	213	304	a	a
31	a	<u>1.83</u>	0	1.0	364	466	a	a
32	a	<u>0.92</u>	0	1.0	183	240	a	a
33	a	<u>1.37</u>	0	1.0	278	379	a	a
34	a	<u>1.83</u>	0	1.0	484	578	a	a

# Report 11

Date : 1923  
 Title : On the maximum load to be carried by the soldier  
 Author(s): Cathcart, Richardson, and Campbell  
 Lab : Physiology Institute, University of Glasgow  
 Type : Laboratory  
 Subjects : 2 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Pack & pouches - 25% of BW	2	69	b	17	25
2	" " " - 30% " "	2	69	b	21	30
3	" " " - 35% " "	2	69	b	25	35
4	" " " - 40% " "	2	69	b	28	40
5	" " " - 45% " "	2	69	b	31	45
6	" " " - 50% " "	2	69	b	35	50
7	" " " - 55% " "	2	69	b	38	55
8	" " " - 60% " "	2	69	b	42	60
9	" " " - 65% " "	2	69	b	45	65
10	Pack & pouches - 35% - very slow	2	69	b	25	35
11	" " " - " - slow	2	69	b	25	35
12	" " " - " - normal	2	69	b	25	35
13	" " " - " - fast	2	69	b	25	35
14	" " " - 40% - very slow	2	69	b	28	40
15	" " " - " - slow	2	69	b	28	40
16	" " " - " - normal	2	69	b	28	40
17	" " " - " - fast	2	69	b	28	40
18	" " " - 45% - very slow	2	69	b	31	45
19	" " " - " - slow	2	69	b	31	45
20	" " " - " - normal	2	69	b	31	45
21	" " " - " - fast	2	69	b	31	45
22	Pack & pouches - 35% - .73m stride	2	69	b	25	35
23	" " " - " - .82m "	2	69	b	25	35
24	" " " - " - .90m "	2	69	b	25	35
25	" " " - 40% - .73m "	2	69	b	28	40
26	" " " - " - .82m "	2	69	b	28	40
27	" " " - " - .90m "	2	69	b	28	40
28	" " " - 45% - .73m "	2	69	b	31	45
29	" " " - " - .82m "	2	69	b	31	45
30	" " " - " - .90m "	2	69	b	31	45
31	Pack & pouches - no rest	2	69	b	28	40
32	" " " - 5 min. rest	2	69	b	28	40
33	" " " - 10 min. rest	2	69	b	28	40
34	" " " - 15 min. rest	2	69	b	28	40
35	" " " - 20 min. rest	2	69	b	28	40



# Report 11

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent. (L/Min)
					Obs.	Pred.			
1	1.39 <sup>c</sup>	1.54	0	1.0	406 <sup>d</sup>	420	a	1.19 <sup>e</sup>	22.0 <sup>f</sup>
2	1.39 <sup>c</sup>	1.54	0	1.0	408 <sup>d</sup>	440	a	1.21 <sup>e</sup>	21.6 <sup>f</sup>
3	1.39 <sup>c</sup>	1.54	0	1.0	413 <sup>d</sup>	463	a	1.22 <sup>e</sup>	21.3 <sup>f</sup>
4	1.39 <sup>c</sup>	1.54	0	1.0	422 <sup>d</sup>	481	a	1.24 <sup>e</sup>	22.9 <sup>f</sup>
5	1.39 <sup>c</sup>	1.54	0	1.0	454 <sup>d</sup>	500	a	1.33 <sup>e</sup>	24.8 <sup>f</sup>
6	1.39 <sup>c</sup>	1.54	0	1.0	475 <sup>d</sup>	527	a	1.39 <sup>e</sup>	26.3 <sup>f</sup>
7	1.39 <sup>c</sup>	1.54	0	1.0	489 <sup>d</sup>	549	a	1.44 <sup>e</sup>	26.9 <sup>f</sup>
8	1.39 <sup>c</sup>	1.54	0	1.0	511 <sup>d</sup>	581	a	1.50 <sup>e</sup>	28.8 <sup>f</sup>
9	1.39 <sup>c</sup>	1.54	0	1.0	562 <sup>d</sup>	606	a	1.61 <sup>e</sup>	32.3 <sup>f</sup>
10	3.02 <sup>c</sup>	0.92	0	1.0	227 <sup>d</sup>	248	a	0.67 <sup>e</sup>	13.3 <sup>f</sup>
11	4.02 <sup>c</sup>	1.22	0	1.0	291 <sup>d</sup>	338	a	0.87 <sup>e</sup>	16.7 <sup>f</sup>
12	5.03 <sup>c</sup>	1.52	0	1.0	423 <sup>d</sup>	454	a	1.26 <sup>e</sup>	22.5 <sup>f</sup>
13	6.03 <sup>c</sup>	1.83	0	1.0	646 <sup>d</sup>	600	a	1.89 <sup>e</sup>	36.0 <sup>f</sup>
14	3.02 <sup>c</sup>	0.92	0	1.0	255 <sup>d</sup>	259	a	0.75 <sup>e</sup>	14.7 <sup>f</sup>
15	4.02 <sup>c</sup>	1.22	0	1.0	290 <sup>d</sup>	352	a	0.87 <sup>e</sup>	15.9 <sup>f</sup>
16	5.03 <sup>c</sup>	1.52	0	1.0	408 <sup>d</sup>	472	a	1.20 <sup>e</sup>	23.0 <sup>f</sup>
17	6.03 <sup>c</sup>	1.83	0	1.0	655 <sup>d</sup>	623	a	1.93 <sup>e</sup>	36.0 <sup>f</sup>
18	3.02 <sup>c</sup>	0.92	0	1.0	267 <sup>d</sup>	271	a	0.79 <sup>e</sup>	15.3 <sup>f</sup>
19	4.02 <sup>c</sup>	1.22	0	1.0	324 <sup>d</sup>	367	a	0.96 <sup>e</sup>	17.8 <sup>f</sup>
20	5.03 <sup>c</sup>	1.52	0	1.0	447 <sup>d</sup>	490	a	1.33 <sup>e</sup>	24.3 <sup>f</sup>
21	6.03 <sup>c</sup>	1.83	0	1.0	667 <sup>d</sup>	646	a	1.94 <sup>e</sup>	38.6 <sup>f</sup>
22	5.49 <sup>c</sup>	1.52	0	1.0	413 <sup>d</sup>	454	a	1.23 <sup>e</sup>	23.2 <sup>f</sup>
23	5.49 <sup>c</sup>	1.52	0	1.0	423 <sup>d</sup>	454	a	1.22 <sup>e</sup>	22.5 <sup>f</sup>
24	5.49 <sup>c</sup>	1.52	0	1.0	419 <sup>d</sup>	454	a	1.24 <sup>e</sup>	25.3 <sup>f</sup>
25	5.49 <sup>c</sup>	1.52	0	1.0	430 <sup>d</sup>	472	a	1.27 <sup>e</sup>	24.6 <sup>f</sup>
26	5.49 <sup>c</sup>	1.52	0	1.0	408 <sup>d</sup>	472	a	1.20 <sup>e</sup>	23.0 <sup>f</sup>
27	5.49 <sup>c</sup>	1.52	0	1.0	462 <sup>d</sup>	472	a	1.37 <sup>e</sup>	25.6 <sup>f</sup>
28	5.49 <sup>c</sup>	1.52	0	1.0	444 <sup>d</sup>	490	a	1.31 <sup>e</sup>	25.3 <sup>f</sup>
29	5.49 <sup>c</sup>	1.52	0	1.0	447 <sup>d</sup>	490	a	1.33 <sup>e</sup>	24.3 <sup>f</sup>
30	5.49 <sup>c</sup>	1.52	0	1.0	500 <sup>d</sup>	490	a	1.49 <sup>e</sup>	26.4 <sup>f</sup>
31	3.50	0.97	0	1.0	255 <sup>d</sup>	272	a	0.76 <sup>e</sup>	14.9 <sup>f</sup>
32	3.50	1.06	0	1.0	264 <sup>d</sup>	299	65	0.78 <sup>e</sup>	15.1 <sup>f</sup>
33	3.50	1.17	0	1.0	299 <sup>d</sup>	335	59	0.89 <sup>e</sup>	16.2 <sup>f</sup>
34	3.50	1.30	0	1.0	315 <sup>d</sup>	381	62	0.93 <sup>e</sup>	17.3 <sup>f</sup>
35	3.50	1.46	0	1.0	364 <sup>d</sup>	446	67	1.09 <sup>e</sup>	20.1 <sup>f</sup>

[continued]

# Report 11 [continued]

Date : 1923  
 Title : On the maximum load to be carried by the soldier  
 Author(s): Cathcart, Richardson, and Campbell  
 Lab : Physiology Institute, University of Glasgow  
 Type : Laboratory  
 Subjects : 2 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
36	Pack & pouches - no rest	2	69	b	28	40
37	" " " - 5 min. rest	2	69	b	28	40
38	" " " - 10 min. rest	2	69	b	28	40
39	" " " - 15 min. rest	2	69	b	28	40
40	" " " - 20 min. rest	2	69	b	28	40
41	Pack & pouches - 35% - w/rest	2	69	b	25	35
42	" " " - " - w/o rest	2	69	b	25	35
43	" " " - 40% - w/rest	2	69	b	28	40
44	" " " - " - w/o rest	2	69	b	28	40
45	" " " - 45% - w/rest	2	69	b	31	45
46	" " " - " - w/o rest	2	69	b	31	45

<sup>a</sup>Data not collected.

<sup>b</sup>Included in load weight.

<sup>c</sup>Minimum distance.

<sup>d</sup>101W (resting expenditure from later portion of study) added to reported net expenditure.

<sup>e</sup>0.30 L/Min (resting consumption from later portion) added to reported net consumption.

<sup>f</sup>5.8 L/Min (resting ventilation from later portion) added to reported net ventilation.

# Report 11

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent.
					Obs.	Pred.			(L/Min)
36	5.01	1.39	0	1.0	360 <sup>d</sup>	417	a	1.07 <sup>e</sup>	19.9 <sup>f</sup>
37	5.01	1.53	0	1.0	413 <sup>d</sup>	476	70	1.22 <sup>e</sup>	24.2 <sup>f</sup>
38	5.01	1.67	0	1.0	480 <sup>d</sup>	541	73	1.41 <sup>e</sup>	26.4 <sup>f</sup>
39	5.01	1.86	0	1.0	655 <sup>d</sup>	639	a	1.93 <sup>e</sup>	36.0 <sup>f</sup>
40	5.01	2.09	0	1.0	865 <sup>d</sup>	771	104	2.50 <sup>e</sup>	55.5 <sup>f</sup>
41	14.07	1.61	0	1.0	479	494	a	1.43	25.6
42	13.45	1.55	0	1.0	461	467	a	1.37	26.7
43	13.91	1.54	0	1.0	419	481	a	1.24	23.5
44	13.14	1.49	0	1.0	434	458	a	1.26	22.9
45	13.78	1.55	0	1.0	509	504	a	1.53	26.4
46	13.49	1.55	0	1.0	510	504	a	1.51	27.9

[concluded]

## Report 12

Date : 1961, September  
 Title : An investigation of portability principles for two-man loads...  
 Author(s): Clark, Torre, and Gschwind  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 12 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	12	79	10 <sup>b</sup>	0 <sup>c</sup>	13
2	Baseplate - 2 man carry	12	79	10 <sup>b</sup>	26 <sup>c</sup>	46
3	Baseplate - 2 man litter carry w/kit	12	79	10 <sup>b</sup>	30 <sup>c</sup>	51
4	Tube - 2 man shoulder carry	12	79	10 <sup>b</sup>	25 <sup>c</sup>	44
5	Tube - 2 man handle carry w/kit	12	79	10 <sup>b</sup>	26 <sup>c</sup>	46
6	Bipod - 2 man carry	12	79	10 <sup>b</sup>	38 <sup>c</sup>	61
7	Bipod - 2 man litter carry w/kit	12	79	10 <sup>b</sup>	39 <sup>c</sup>	62
8	Bipod - 2 man litter carry w/kit No.1	10	80	10 <sup>b</sup>	39 <sup>c</sup>	62
9	Bipod - 2 man litter carry w/kit No.2	10	80	10 <sup>b</sup>	40 <sup>c</sup>	63
10	Squad carry	12	79	10 <sup>b</sup>	31 <sup>d</sup>	52

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Load weight per carrier.

<sup>d</sup>Mean load weight per subject for all.

<sup>e</sup>Completed only two laps because of "extreme difficulty in carrying the bipod."

<sup>f</sup>Includes adjustment for hand-carried loads:  $0.014(\text{Load Wgt})^2(\text{Speed})^2$ .

# Report 12

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>0.82</u>	1.30	0	1.5	a	460 <sup>f</sup>	a	a
2	<u>0.82</u>	0.59	0	1.5	a	263 <sup>f</sup>	a	a
3	<u>0.82</u>	0.99	0	1.5	a	464 <sup>f</sup>	a	a
4	<u>0.82</u>	0.94	0	1.5	a	390 <sup>f</sup>	a	a
5	<u>0.82</u>	0.84	0	1.5	a	362 <sup>f</sup>	a	a
6	<u>0.41</u> <sup>e</sup>	0.38	0	1.5	a	358 <sup>f</sup>	a	a
7	<u>0.82</u>	0.54	0	1.5	a	311 <sup>f</sup>	a	a
8	<u>0.82</u>	0.59	0	1.5	a	330 <sup>f</sup>	a	a
9	<u>0.82</u>	0.70	0	1.5	a	382 <sup>f</sup>	a	a
10	<u>0.82</u>	0.76	0	1.5	a	353 <sup>f</sup>	a	a



# Report 13

Date : 1977, August  
 Title : TOW squad member loads  
 Author(s): Corona  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 8 airborne infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - light infantry	8	73 <sup>b</sup>	13	7 <sup>c</sup>	27
2	TOW squad leader	8	73 <sup>b</sup>	13	36	67
3	TOW gunner	8	73 <sup>b</sup>	13	35	66
4	TOW assistant gunner	8	73 <sup>b</sup>	13	29	58
5	Driver/RT0	8	73 <sup>b</sup>	13	44	78

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for US Army soldiers, Ref. 131.

<sup>c</sup>Assumed.

<sup>d</sup>Approximate.

# Report 13

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>3.79</u>	1.90 <sup>d</sup>	0	1.2	a	728	a	a
2	<u>3.79</u>	0.75 <sup>d</sup>	0	1.2	a	343	a	a
3	<u>3.79</u>	0.75 <sup>d</sup>	0	1.2	a	337	a	a
4	<u>3.79</u>	0.75 <sup>d</sup>	0	1.2	a	302	a	a
5	<u>3.79</u>	0.75 <sup>d</sup>	0	1.2	a	400	a	a

# Report 14

Date : 1974, October  
 Title : Human factors evaluation of two proposed...fragmentation protective systems  
 Author(s): Corona, Jones, Randall, Ellis, and Bruno  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 36 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Helmet/Vest System I	36	71	19	0	27
2	Helmet/Vest System II	36	71	20	0	28
3	Helmet/Vest System III	36	71	20	0	28

<sup>a</sup>Data not collected

# Report 15

Date : 1959  
 Title : Physical training in relation to the energy expenditure of walking..  
 Author(s): Cotes and Meade  
 Lab : Llandough Hospital, Wales  
 Type : Treadmill  
 Subjects : 11 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Before training	11	60	3 <sup>b</sup>	0	5
2	During training 1	11	60	3 <sup>b</sup>	0	5
3	" " 2	11	61	3 <sup>b</sup>	0	5
4	After training for ten weeks	11	62	3 <sup>b</sup>	0	5

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

# Report 14

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	<u>3.47</u>	a	0	1.5	a	a	a	a
2	<u>3.47</u>	a	0	1.5	a	a	a	a
3	<u>3.47</u>	a	0	1.5	a	a	a	a

# Report 15

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	a	<u>1.56</u>	0	1.0	363	320	a	a
2	a	<u>1.56</u>	0	1.0	350	320	a	a
3	a	<u>1.56</u>	0	1.0	343	325	a	a
4	a	<u>1.56</u>	0	1.0	319	331	a	a

# Report 16

Date : 1960  
 Title : The energy expenditure and mechanical energy demand in walking  
 Author(s): Cotes and Meade  
 Lab : Pneumoconiosis Research Unit, Llandough Hospital, Wales  
 Type : Treadmill  
 Subjects : 11 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	0% grade - 1 mph	11	61	2 <sup>b</sup>	0	3
2	" - 2 mph	11	61	2 <sup>b</sup>	0	3
3	" - 3 mph	11	61	2 <sup>b</sup>	0	3
4	" - 3.5 mph	10	61	2 <sup>b</sup>	0	3
5	" - 4 mph	11	61	2 <sup>b</sup>	0	3
6	4% grade - 1 mph	2	65	2 <sup>b</sup>	0	3
7	" - 2 mph	2	65	2 <sup>b</sup>	0	3
8	" - 3 mph	2	65	2 <sup>b</sup>	0	3
9	" - 4 mph	2	65	2 <sup>b</sup>	0	3
10	8% grade - 1 mph	2	65	2 <sup>b</sup>	0	3
11	" - 2 mph	2	65	2 <sup>b</sup>	0	3
12	" - 3 mph	2	65	2 <sup>b</sup>	0	3
13	" - 4 mph	2	65	2 <sup>b</sup>	0	3
14	12% grade - 1 mph	2	65	2 <sup>b</sup>	0	3
15	" - 2 mph	2	65	2 <sup>b</sup>	0	3
16	" - 3 mph	2	65	2 <sup>b</sup>	0	3
17	" - 4 mph	2	65	2 <sup>b</sup>	0	3
18	- 2% grade - 1 mph	1	68	2 <sup>b</sup>	0	3
19	" - 2 mph	1	68	2 <sup>b</sup>	0	3
20	" - 3 mph	1	68	2 <sup>b</sup>	0	3
21	" - 4 mph	1	68	2 <sup>b</sup>	0	3
22	- 4% grade - 1 mph	1	68	2 <sup>b</sup>	0	3
23	" - 2 mph	1	68	2 <sup>b</sup>	0	3
24	" - 3 mph	1	68	2 <sup>b</sup>	0	3
25	" - 4 mph	1	68	2 <sup>b</sup>	0	3
26	- 8% grade - 1 mph	10	61	2 <sup>b</sup>	0	3
27	" - 2 mph	10	61	2 <sup>b</sup>	0	3
28	" - 3 mph	10	61	2 <sup>b</sup>	0	3
29	" - 4 mph	10	61	2 <sup>b</sup>	0	3
30	- 12% grade - 1 mph	1	68	2 <sup>b</sup>	0	3
31	" - 2 mph	1	68	2 <sup>b</sup>	0	3
32	" - 3 mph	1	68	2 <sup>b</sup>	0	3
33	" - 4 mph	1	68	2 <sup>b</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Formula unable to predict for negative slopes.



# Report 16

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Steps/Min.
					Obs.	Pred.			
1	a	<u>0.44</u>	0	1.0	184	110	a	a	62
2	a	<u>0.90</u>	0	1.0	226	168	a	a	86
3	a	<u>1.33</u>	0	1.0	275	259	a	a	107
4	a	<u>1.54</u>	0	1.0	319	316	a	a	116
5	a	<u>1.77</u>	0	1.0	381	388	a	a	124
6	a	<u>0.44</u>	4	1.0	237	158	a	a	56
7	a	<u>0.89</u>	4	1.0	292	261	a	a	84
8	a	<u>1.33</u>	4	1.0	410	400	a	a	106
9	a	<u>1.81</u>	4	1.0	572	597	a	a	120
10	a	<u>0.45</u>	8	1.0	268	202	a	a	57
11	a	<u>0.90</u>	8	1.0	373	348	a	a	85
12	a	<u>1.35</u>	8	1.0	509	534	a	a	107
13	a	<u>1.80</u>	8	1.0	688	761	a	a	121
14	a	<u>0.45</u>	12	1.0	308	245	a	a	61
15	a	<u>0.91</u>	12	1.0	481	437	a	a	89
16	a	<u>1.34</u>	12	1.0	657	655	a	a	106
17	a	<u>1.80</u>	12	1.0	817	930	a	a	122
18	a	<u>0.42</u>	-2	1.0	164	c	a	a	58
19	a	<u>0.91</u>	-2	1.0	197	c	a	a	88
20	a	<u>1.31</u>	-2	1.0	237	c	a	a	105
21	a	<u>1.73</u>	-2	1.0	322	c	a	a	121
22	a	<u>0.42</u>	-4	1.0	156	c	a	a	61
23	a	<u>0.86</u>	-4	1.0	187	c	a	a	87
24	a	<u>1.29</u>	-4	1.0	232	c	a	a	106
25	a	<u>1.74</u>	-4	1.0	319	c	a	a	122
26	a	<u>0.43</u>	-8	1.0	146	c	a	a	67
27	a	<u>0.90</u>	-8	1.0	165	c	a	a	90
28	a	<u>1.32</u>	-8	1.0	197	c	a	a	110
29	a	<u>1.76</u>	-8	1.0	269	c	a	a	126
30	a	<u>0.42</u>	-12	1.0	153	c	a	a	67
31	a	<u>0.88</u>	-12	1.0	185	c	a	a	97
32	a	<u>1.29</u>	-12	1.0	225	c	a	a	113
33	a	<u>1.76</u>	-12	1.0	296	c	a	a	124

# Report 17

Date : 1954, March  
 Title : A study of the experimental pack T 53-8  
 Author(s): Daniels, Lyman, and Vanderbie  
 Lab : Quartermaster Research and Development Center, US Army  
 Type : Treadmill  
 Subjects : 4 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	4	71	3 <sup>b</sup>	0	4
2	25 lb T 53-8 pack	4	71	3 <sup>b</sup>	11	20
3	" standard pack	4	71	3 <sup>b</sup>	11	20
4	" packboard	4	71	3 <sup>b</sup>	11	20
5	40 lb T 53-8 pack	4	71	3 <sup>b</sup>	18	30
6	" packboard	4	71	3 <sup>b</sup>	18	30
7	Control - no load	4	71	3 <sup>b</sup>	0	4
8	25 lb T 53-8 pack	4	71	3 <sup>b</sup>	11	20
9	" standard pack	4	71	3 <sup>b</sup>	11	20
10	" packboard	4	71	3 <sup>b</sup>	11	20
11	" UK pack	4	71	3 <sup>b</sup>	11	20
12	Control - no load	4	71	3 <sup>b</sup>	0	4
13	25 lb T 53-8 pack	4	71	3 <sup>b</sup>	11	20
14	" standard pack	4	71	3 <sup>b</sup>	11	20
15	" packboard	4	71	3 <sup>b</sup>	11	20
16	" UK pack	4	71	3 <sup>b</sup>	11	20

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>At 1.12 mps, each subject's gait was noticeably unstable.

<sup>d</sup>Only three of the four subjects used.

# Report 17

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	a	<u>1.12<sup>c</sup></u>	0	1.0	295	246	a	a
2	a	<u>1.12<sup>c</sup></u>	0	1.0	333	273	a	a
3	a	<u>1.12<sup>c</sup></u>	0	1.0	321	273	a	a
4	a	<u>1.12<sup>c</sup></u>	0	1.0	300	273	a	a
5	a	<u>1.12<sup>c</sup></u>	0	1.0	333	296	a	a
6	a	<u>1.12<sup>c</sup></u>	0	1.0	337	296	a	a
7	a	<u>1.56</u>	0	1.0	391	377	91 <sup>d</sup>	a
8	a	<u>1.56</u>	0	1.0	439	423	95 <sup>d</sup>	a
9	a	<u>1.56</u>	0	1.0	427	423	97 <sup>d</sup>	a
10	a	<u>1.56</u>	0	1.0	429	423	a	a
11	a	<u>1.56</u>	0	1.0	452	423	a	a
12	a	<u>2.24</u>	0	1.0	847	664	a	a
13	a	<u>2.24</u>	0	1.0	877	753	a	a
14	a	<u>2.24</u>	0	1.0	927	753	a	a
15	a	<u>2.24</u>	0	1.0	973	753	a	a
16	a	<u>2.24</u>	0	1.0	1029	753	a	a

# Report 18

Date : 1953, March  
 Title : Energy cost of carrying three load distributions on a treadmill  
 Author(s): Daniels, Vanderbie, and Bommarito  
 Lab : Quartermaster Climatic Research Laboratory  
 Type : Treadmill  
 Subjects : 6 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	6	72	3 <sup>b</sup>	0	4
2	25 lb - high (on packboard)	6	72	3 <sup>b</sup>	14	24
3	" - low (on packboard)	6	72	3 <sup>b</sup>	14	24
4	" - saddle bags	6	72	3 <sup>b</sup>	12	21
5	40 lb - high	6	72	3 <sup>b</sup>	21	33
6	" - low	6	72	3 <sup>b</sup>	21	33
7	" - saddle bags	6	72	3 <sup>b</sup>	19	31
8	55 lb - high	6	72	3 <sup>b</sup>	28	43
9	" - low	6	72	3 <sup>b</sup>	28	43
10	" - saddle bags	6	72	3 <sup>b</sup>	29	44
11	70 lb - high	6	72	3 <sup>b</sup>	35	53
12	" - low	6	72	3 <sup>b</sup>	35	53
13	" - saddle bags	6	72	3 <sup>b</sup>	36	54

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

# Report 19

Date : 1953, August  
 Title : Energy cost of treadmill walking compared to road walking  
 Author(s): Daniels, Vanderbie, and Winsmann  
 Lab : Natick QM Research and Development Laboratory  
 Type : Treadmill and field  
 Subjects : 13 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Treadmill - pack	8	66	4	21	38
2	Blacktop Road - pack	8	66	4	21	38
3	Treadmill - 8 lb armored vest	4	64	4	4	12
4	Blacktop Road - 8 lb armored vest	4	64	4	4	12

<sup>a</sup>Data not collected.

<sup>b</sup>Mean grade estimated from textual details.

# Report 18

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Forward Lean(°)
					Obs.	Pred.			
1	<u>2.82</u>	<u>1.56</u>	0	1.0	a	382	116	0.94	a
2	<u>2.82</u>	<u>1.56</u>	0	1.0	a	443	115	1.14	4
3	<u>2.82</u>	<u>1.56</u>	0	1.0	a	443	130	1.12	4
4	<u>2.82</u>	<u>1.56</u>	0	1.0	a	433	124	1.21	4
5	<u>2.82</u>	<u>1.56</u>	0	1.0	a	480	127	1.23	9
6	<u>2.82</u>	<u>1.56</u>	0	1.0	a	480	132	1.22	8
7	<u>2.82</u>	<u>1.56</u>	0	1.0	a	469	123	1.31	4
8	<u>2.82</u>	<u>1.56</u>	0	1.0	a	522	134	1.33	9
9	<u>2.82</u>	<u>1.56</u>	0	1.0	a	522	128	1.29	10
10	<u>2.82</u>	<u>1.56</u>	0	1.0	a	529	135	1.49	5
11	<u>2.82</u>	<u>1.56</u>	0	1.0	a	571	142	1.58	12
12	<u>2.82</u>	<u>1.56</u>	0	1.0	a	571	142	1.49	17
13	<u>2.82</u>	<u>1.56</u>	0	1.0	a	578	142	1.53	7

# Report 19

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	a	<u>1.56</u>	0	1.0	439	457	a	1.31
2	<u>1.65</u>	<u>1.56</u>	0.33 <sup>b</sup>	1.0	478	474	a	1.43
3	a	<u>1.56</u>	0	1.0	374	361	a	1.11
4	<u>1.65</u>	<u>1.56</u>	0.33 <sup>b</sup>	1.0	409	374	a	1.22



## Report 20

Date : 1973  
 Title : The relationship between energy expenditure and pulse rates with...  
           the load carried...  
 Author(s): Datta, Chatterjee, and Roy  
 Lab : All-India Institute of Hygiene and Public Health  
 Type : Field  
 Subjects : 10 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	6	51	1 <sup>b</sup>	0	2
2	20kg on head	6	51	1 <sup>b</sup>	20	41
3	30kg on head	6	51	1 <sup>b</sup>	30	61
4	40kg on head	6	51	1 <sup>b</sup>	40	80
5	50kg on head	6	51	1 <sup>b</sup>	50	100
6	Control - no load	4	52	1 <sup>b</sup>	0	2
7	10kg on head	4	52	1 <sup>b</sup>	10	21
8	20kg on head	4	52	1 <sup>b</sup>	20	40
9	30kg on head	4	52	1 <sup>b</sup>	30	60

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details and derived data.

<sup>c</sup>Derived from regression equation given in Fig. 1 of Report 20.

<sup>d</sup>Derived from regression equation given in Fig. 2 of Report 20.

## Report 21

Date : 1975  
 Title : Maximum permissible weight to be carried on the head by a male...  
           from...India  
 Author(s): Datta, Chatterjee, and Roy  
 Lab : All-India Institute of Hygiene and Public Health  
 Type : Field  
 Subjects : 6 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	6	51	2 <sup>b</sup>	0	4
2	20 kg in basket on head	6	51	2 <sup>b</sup>	20	43
3	30 kg in basket on head	6	51	2 <sup>b</sup>	30	63
4	40 kg in basket on head	6	51	2 <sup>b</sup>	40	82
5	50 kg in basket on head	6	51	2 <sup>b</sup>	50	102

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.

# Report 20

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.00</u>	<u>1.39</u>	0	1.0	192 <sup>c</sup>	227	91 <sup>d</sup>	a
2	<u>1.00</u>	<u>1.39</u>	0	1.0	323 <sup>c</sup>	310	116 <sup>d</sup>	a
3	<u>1.00</u>	<u>1.39</u>	0	1.0	389 <sup>c</sup>	375	128 <sup>d</sup>	a
4	<u>1.00</u>	<u>1.39</u>	0	1.0	455 <sup>c</sup>	462	141 <sup>d</sup>	a
5	<u>1.00</u>	<u>1.39</u>	0	1.0	521 <sup>c</sup>	576	153 <sup>d</sup>	a
6	<u>1.00</u>	<u>1.39</u>	0	1.0	189	232	103	a
7	<u>1.00</u>	<u>1.39</u>	0	1.0	246	266	112	a
8	<u>1.00</u>	<u>1.39</u>	0	1.0	330	313	118	a
9	<u>1.00</u>	<u>1.39</u>	0	1.0	405	378	134	a

# Report 21

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent (L/Min)
					Obs.	Pred.			
1	<u>1.00</u>	<u>1.39</u>	0	1.1	219	246	101	0.66	14.4
2	<u>1.00</u>	<u>1.39</u>	0	1.1	304	336	108	0.91	22.9
3	<u>1.00</u>	<u>1.39</u>	0	1.1	361	406	123	1.08	27.4
4	<u>1.00</u>	<u>1.39</u>	0	1.1	448	499	142	1.34	32.4
5	<u>1.00</u>	<u>1.39</u>	0	1.1	552	619	156	1.66	38.7

## Report 22

Date : 1978  
 Title : The energy cost of rickshaw pulling  
 Author(s): Datta, Chatterjee, and Roy  
 Lab : All-India Institute of Hygiene and Public Health  
 Type : Field  
 Subjects : 10 male professional rickshaw pullers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Rickshaw - empty	10	48	2 <sup>b</sup>	80	171
2	Rickshaw - w/50 kg load	10	48	2 <sup>b</sup>	130	275
3	Rickshaw - w/100 kg load	10	48	2 <sup>b</sup>	180	379
4	Rickshaw - w/150 kg load	10	48	2 <sup>b</sup>	230	483

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

## Report 23

Date : 1971  
 Title : Ergonomic comparison of seven modes of carrying loads on the horizontal plane.  
 Author(s): Datta and Ramanathan  
 Lab : All-India Institute of Hygiene and Public Health  
 Type : Field  
 Subjects : 7 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Front and back packs	7	50	2 <sup>b</sup>	30	64
2	Head basket	7	50	2 <sup>b</sup>	30	64
3	Rucksack	7	50	2 <sup>b</sup>	30	64
4	Back sack w/head straps	7	50	2 <sup>b</sup>	30	64
5	Back sack - hand held	7	50	2 <sup>b</sup>	30	64
6	Shoulder pole - front and back loads	7	50	2 <sup>b</sup>	30	64
7	Two hand-held sacks	7	50	2 <sup>b</sup>	30	64

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

# Report 22

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent. (L/Min)
					Obs.	Pred.			
1	<u>0.84</u>	<u>1.40</u>	a	a	286	a	107	a	19.2
2	<u>0.84</u>	<u>1.40</u>	a	a	380	a	123	a	23.2
3	<u>0.84</u>	<u>1.40</u>	a	a	473	a	131	a	27.2
4	<u>0.84</u>	<u>1.40</u>	a	a	614	a	143	a	34.9

# Report 23

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent. (L/Min)
					Obs.	Pred.			
1	<u>1.00</u>	<u>1.39</u>	0	1.1	337	404	137	1.01	28.1
2	<u>1.00</u>	<u>1.39</u>	0	1.1	348	404	145	1.04	27.5
3	<u>1.00</u>	<u>1.39</u>	0	1.1	368	404	146	1.11	30.2
4	<u>1.00</u>	<u>1.39</u>	0	1.1	387	404	137	1.16	31.1
5	<u>1.00</u>	<u>1.39</u>	0	1.1	414	404	143	1.22	33.0
6	<u>1.00</u>	<u>1.39</u>	0	1.1	434	404	149	1.30	35.3
7	<u>1.00</u>	<u>1.39</u>	0	1.1	486	404	166	1.46	39.6

# Report 24

Date : 1978, March  
 Title : Forward observer transportability test  
 Author(s): Dousa and Brainerd  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 22 male soldiers (Airborne)

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	22	73 <sup>b</sup>	19	0	27
2	PRC-77 pack load A	22	73 <sup>b</sup>	19	15	46
3	PRC-77 and DMD pack load A	22	73 <sup>b</sup>	19	19	53
4	PRC-77 and DMD pack load B	22	73 <sup>b</sup>	19	15	47
5	PRC-77 pack load B	22	73 <sup>b</sup>	19	10	40
6	STTM w/ bandoleer strap	22	73 <sup>b</sup>	19	10	41
7	GVS-5 and tripod on packboard	11	73 <sup>b</sup>	19	15	48
8	LTD on packboard	11	73 <sup>b</sup>	19	6	35
9	GVS-5, tripod, and LTD on packboard	11	73 <sup>b</sup>	19	21	56
10	GVS-5 and LTD on packboard	11	73 <sup>b</sup>	19	12	43
11	GVS-5, LTD, and STTM on packboard	11	73 <sup>b</sup>	19	23	58
12	Nightsight support gear in pack	11	73 <sup>b</sup>	19	18	51
13	Nightsight support gear on packboard	11	73 <sup>b</sup>	19	21	55
14	Nightsight pack	11	73 <sup>b</sup>	19	18	51
15	MULE slung	11	73 <sup>b</sup>	19	7	37
16	MULE and STTM on packboard	11	73 <sup>b</sup>	19	18	51
17	GLLD backpack	11	73 <sup>b</sup>	19	17	50
18	Traversing unit backpack	11	73 <sup>b</sup>	19	12	43
19	GLLD (HEL case) on ALICE frame	11	73 <sup>b</sup>	19	21	56
20	Traversing unit (HEL) on ALICE frame	11	73 <sup>b</sup>	19	16	48
21	Traversing unit and PRC-77 on frame	11	73 <sup>b</sup>	19	23	58

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for US Army soldier (Ref. 131).



# Report 24

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.00</u>	1.78	0	1.1	a	602	a	a
2	<u>1.00</u>	1.54	0	1.1	a	575	a	a
3	<u>1.00</u>	1.50	0	1.1	a	589	a	a
4	<u>1.00</u>	1.61	0	1.1	a	614	a	a
5	<u>1.00</u>	1.55	0	1.1	a	546	a	a
6	<u>1.00</u>	1.54	0	1.1	a	547	a	a
7	<u>1.00</u>	1.60	0	1.1	a	615	a	a
8	<u>1.00</u>	1.68	0	1.1	a	589	a	a
9	<u>1.00</u>	1.46	0	1.1	a	582	a	a
10	<u>1.00</u>	1.53	0	1.1	a	555	a	a
11	<u>1.00</u>	1.40	0	1.1	a	558	a	a
12	<u>1.00</u>	1.43	0	1.1	a	537	a	a
13	<u>1.00</u>	1.49	0	1.1	a	591	a	a
14	<u>1.00</u>	1.57	0	1.1	a	613	a	a
15	<u>1.00</u>	1.54	0	1.1	a	528	a	a
16	<u>1.00</u>	1.37	0	1.1	a	507	a	a
17	<u>1.00</u>	1.43	0	1.1	a	530	a	a
18	<u>1.00</u>	1.48	0	1.1	a	523	a	a
19	<u>1.00</u>	1.36	0	1.1	a	529	a	a
20	<u>1.00</u>	1.46	0	1.1	a	539	a	a
21	<u>1.00</u>	1.41	0	1.1	a	563	a	a

# Report 25

Date : 1966, April  
 Title : The effect of hot environments on the energy metabolism of men performing...work  
 Author(s): Durnin, Haisman, Peters, and Zurick  
 Lab : Army Personnel Research Establishment, Great Britain  
 Type : Laboratory  
 Subjects : 6 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	First acclimation march	6	75	b	25	33
2	Second " "	6	75	b	25	33
3	Third " "	6	75	b	25	33
4	Fourth " "	6	75	b	25	33
5	Fifth " "	6	75	b	25	33
6	Sixth " "	6	75	b	25	33
7	Seventh " "	6	75	b	25	33
8	Eighth " "	6	75	b	25	33
9	Ninth " "	6	75	b	25	33
10	Temperate climate - all loads combined	6	75	b	21	28
11	Hot/Dry climate - all loads combined	6	75	b	21	28
12	Hot/Wet climate - all loads combined	6	75	b	21	28
13	Light load - all climates combined	6	75	b	13	18
14	Medium load - " "	6	75	b	21	28
15	Heavy load - " "	6	75	b	28	37

<sup>a</sup>Data not collected.

<sup>b</sup>Included in load weight.

# Report 25

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Rectal Temp. °C
					Obs.	Pred.			
1	<u>3.45</u>	<u>1.28</u>	0	1.0	a	380	166	a	38.9
2	<u>4.60</u>	<u>1.28</u>	0	1.0	a	380	152	a	38.6
3	<u>5.37</u>	<u>1.28</u>	0	1.0	a	380	148	a	38.7
4	<u>6.13</u>	<u>1.28</u>	0	1.0	a	380	148	a	38.6
5	<u>6.52</u>	<u>1.28</u>	0	1.0	a	380	146	a	38.5
6	<u>6.90</u>	<u>1.28</u>	0	1.0	a	380	137	a	38.4
7	<u>6.90</u>	<u>1.28</u>	0	1.0	a	380	145	a	38.3
8	<u>6.90</u>	<u>1.28</u>	0	1.0	a	380	147	a	38.2
9	<u>6.90</u>	<u>1.28</u>	0	1.0	a	380	152	a	38.2
10	<u>4.51</u>	<u>1.28</u>	0	1.0	360	363	92	a	37.6
11	<u>4.51</u>	<u>1.28</u>	0	1.0	391	363	120	a	37.9
12	<u>4.51</u>	<u>1.28</u>	0	1.0	380	363	120	a	37.8
13	<u>4.51</u>	<u>1.28</u>	0	1.0	357	334	106	a	37.7
14	<u>4.51</u>	<u>1.28</u>	0	1.0	376	363	109	a	37.8
15	<u>4.51</u>	<u>1.28</u>	0	1.0	398	394	116	a	37.8

# Report 26

Date : 1980  
 Title : Self-paced hard work comparing men and women  
 Author(s): Evans, Winsmann, Pandolf, and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Field  
 Subjects : 6 men and 6 women

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Men - no load - blacktop road	6	67	3 <sup>b</sup>	0	4
2	" - " - dirt road	6	67	3 <sup>b</sup>	0	4
3	" - " - light brush	6	67	3 <sup>b</sup>	0	4
4	" - " - heavy brush	6	67	3 <sup>b</sup>	0	4
5	" - 10 kg pack - blacktop road	6	67	3 <sup>b</sup>	10	15
6	" - " - dirt road	6	67	3 <sup>b</sup>	10	15
7	" - " - light brush	6	67	3 <sup>b</sup>	10	15
8	" - " - heavy brush	6	67	3 <sup>b</sup>	10	15
9	" - 20 kg pack - blacktop road	6	67	3 <sup>b</sup>	20	34
10	" - " - dirt road	6	67	3 <sup>b</sup>	20	34
11	" - " - light brush	6	67	3 <sup>b</sup>	20	34
12	" - " - heavy brush	6	67	3 <sup>b</sup>	20	34
13	Women - no load - blacktop road	6	57	3 <sup>b</sup>	0	5
14	" - " - dirt road	6	57	3 <sup>b</sup>	0	5
15	" - " - light brush	6	57	3 <sup>b</sup>	0	5
16	" - " - heavy brush	6	57	3 <sup>b</sup>	0	5
17	" - 10 kg pack - blacktop road	6	57	3 <sup>b</sup>	10	23
18	" - " - dirt road	6	57	3 <sup>b</sup>	10	23
19	" - " - light brush	6	57	3 <sup>b</sup>	10	23
20	" - " - heavy brush	6	57	3 <sup>b</sup>	10	23
21	" - 20 kg pack - blacktop road	6	57	3 <sup>b</sup>	20	40
22	" - " - dirt road	6	57	3 <sup>b</sup>	20	40
23	" - " - light brush	6	57	3 <sup>b</sup>	20	40
24	" - " - heavy brush	6	57	3 <sup>b</sup>	20	40

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Heart rates averaged across terrain.

<sup>d</sup>Predicted by authors.

# Report 26

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.60</u>	2.16	0	1.0	a	572 <sup>d</sup>	110 <sup>c</sup>	1.61
2	<u>1.80</u>	2.03	0	1.1	a	522 <sup>d</sup>	110 <sup>c</sup>	1.44
3	<u>1.40</u>	1.97	0	1.2	a	555 <sup>d</sup>	110 <sup>c</sup>	1.54
4	<u>1.30</u>	1.75	0	1.5	a	562 <sup>d</sup>	110 <sup>c</sup>	1.54
5	<u>1.60</u>	1.92	0	1.0	a	527 <sup>d</sup>	109 <sup>c</sup>	1.48
6	<u>1.80</u>	1.76	0	1.1	a	463 <sup>d</sup>	109 <sup>c</sup>	1.31
7	<u>1.40</u>	1.82	0	1.2	a	547 <sup>d</sup>	109 <sup>c</sup>	1.54
8	<u>1.30</u>	1.52	0	1.5	a	505 <sup>d</sup>	109 <sup>c</sup>	1.41
9	<u>1.60</u>	1.91	0	1.0	a	593 <sup>d</sup>	110 <sup>c</sup>	1.64
10	<u>1.80</u>	1.81	0	1.1	a	544 <sup>d</sup>	110 <sup>c</sup>	1.51
11	<u>1.40</u>	1.83	0	1.2	a	615 <sup>d</sup>	110 <sup>c</sup>	1.71
12	<u>1.30</u>	1.54	0	1.5	a	579 <sup>d</sup>	110 <sup>c</sup>	1.61
13	<u>1.60</u>	1.91	0	1.0	a	390 <sup>d</sup>	110 <sup>c</sup>	1.10
14	<u>1.80</u>	1.76	0	1.1	a	350 <sup>d</sup>	110 <sup>c</sup>	0.99
15	<u>1.40</u>	1.78	0	1.2	a	392 <sup>d</sup>	110 <sup>c</sup>	1.13
16	<u>1.30</u>	1.38	0	1.5	a	327 <sup>d</sup>	110 <sup>c</sup>	0.92
17	<u>1.60</u>	1.74	0	1.0	a	398 <sup>d</sup>	108 <sup>c</sup>	1.13
18	<u>1.80</u>	1.63	0	1.1	a	359 <sup>d</sup>	108 <sup>c</sup>	1.01
19	<u>1.40</u>	1.56	0	1.2	a	376 <sup>d</sup>	108 <sup>c</sup>	1.06
20	<u>1.30</u>	1.25	0	1.5	a	334 <sup>d</sup>	108 <sup>c</sup>	0.94
21	<u>1.60</u>	1.59	0	1.0	a	398 <sup>d</sup>	110 <sup>c</sup>	1.13
22	<u>1.80</u>	1.48	0	1.1	a	363 <sup>d</sup>	110 <sup>c</sup>	1.03
23	<u>1.40</u>	1.40	0	1.2	a	372 <sup>d</sup>	110 <sup>c</sup>	1.06
24	<u>1.30</u>	0.99	0	1.5	a	324 <sup>d</sup>	110 <sup>c</sup>	0.94



# Report 27

Date : 1977  
 Title : Modular pack mine system (MOPMS): Human factors engineering plan  
 Author(s): Furuike  
 Lab : Aerojet Ordnance and Manufacturing Company  
 Type : Field  
 Subjects : 12 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	2-man litter-100 lb box - hand grips	12	72	9	23 <sup>b</sup>	43
2	2-man litter-100 lb box - handles	12	72	9	23 <sup>b</sup>	43
3	2-man litter-100 lb box - poles	12	72	9	23 <sup>b</sup>	43
4	2-man litter-125 lb box - hand grips	12	72	9	28 <sup>b</sup>	51
5	2-man litter-125 lb box - handles	12	72	9	28 <sup>b</sup>	51
6	2-man litter-125 lb box - poles	12	72	9	28 <sup>b</sup>	51
7	2-man litter-150 lb box - hand grips	12	72	9	34 <sup>b</sup>	59
8	2-man litter-150 lb box - handles	12	72	9	34 <sup>b</sup>	59
9	2-man litter-150 lb box - poles	12	72	9	34 <sup>b</sup>	59
10	2-man litter-100 lb box - hand grips	4	58	9	23 <sup>b</sup>	55
11	2-man litter-100 lb box - handles	4	58	9	23 <sup>b</sup>	55
12	2-man litter-100 lb box - poles	4	58	9	23 <sup>b</sup>	55
13	2-man litter-125 lb box - hand grips	4	58	9	28 <sup>b</sup>	64
14	2-man litter-125 lb box - handles	4	58	9	28 <sup>b</sup>	64
15	2 man litter-125 lb box - poles	4	58	9	28 <sup>b</sup>	64
16	2-man litter-150 lb box - hand grips	4	58	9	34 <sup>b</sup>	74
17	2-man litter-150 lb box - handles	4	58	9	34 <sup>b</sup>	74
18	2-man litter-150 lb box - poles	4	58	9	34 <sup>b</sup>	74
19	4-man litter-100 lb box - hand grips	12	72	9	11 <sup>b</sup>	28
20	4-man litter-100 lb box - handles	12	72	9	11 <sup>b</sup>	28
21	4-man litter-100 lb box - poles	12	72	9	11 <sup>b</sup>	28
22	4-man litter-100 lb box - hand grips	12	72	9	14 <sup>b</sup>	32

Report 27

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>0.02</u>	0.62	a	1.2	a	227 <sup>c</sup>	a	a
2	<u>0.02</u>	0.65	a	1.2	a	234 <sup>c</sup>	a	a
3	<u>0.02</u>	0.67	a	1.2	a	240 <sup>c</sup>	a	a
4	<u>0.02</u>	0.63	a	1.2	a	251 <sup>c</sup>	a	a
5	<u>0.02</u>	0.64	a	1.2	a	254 <sup>c</sup>	a	a
6	<u>0.02</u>	0.64	a	1.2	a	254 <sup>c</sup>	a	a
7	<u>0.02</u>	0.50	a	1.2	a	248 <sup>c</sup>	a	a
8	<u>0.02</u>	0.64	a	1.2	a	285 <sup>c</sup>	a	a
9	<u>0.02</u>	0.63	a	1.2	a	282 <sup>c</sup>	a	a
10	<u>0.10</u>	0.96	a	1.2	a	304 <sup>c</sup>	a	a
11	<u>0.10</u>	0.90	a	1.2	a	285 <sup>c</sup>	a	a
12	<u>0.10</u>	0.97	a	1.2	a	308 <sup>c</sup>	a	a
13	<u>0.10</u>	0.94	a	1.2	a	332 <sup>c</sup>	a	a
14	<u>0.10</u>	0.83	a	1.2	a	295 <sup>c</sup>	a	a
15	<u>0.10</u>	1.08	a	1.2	a	386 <sup>c</sup>	a	a
16	<u>0.10</u>	0.73	a	1.2	a	309 <sup>c</sup>	a	a
17	<u>0.10</u>	0.94	a	1.2	a	382 <sup>c</sup>	a	a
18	<u>0.10</u>	0.85	a	1.2	a	348 <sup>c</sup>	a	a
19	<u>0.20</u>	1.04	a	1.2	a	307 <sup>c</sup>	a	a
20	<u>0.20</u>	0.93	a	1.2	a	270 <sup>c</sup>	a	a
21	<u>0.20</u>	1.03	a	1.2	a	304 <sup>c</sup>	a	a
22	<u>0.20</u>	0.97	a	1.2	a	295 <sup>c</sup>	a	a

[continued]

Report 27 [continued]

Date : 1977  
 Title : Modular pack mine system (MOPMS): Human factors engineering plan  
 Author(s): Furuike  
 Lab : Aerojet Ordnance and Manufacturing Company  
 Type : Field  
 Subjects : 12 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
23	4-man litter-125 lb box - handles	12	72	9	14 <sup>b</sup>	32
24	4-man litter-125 lb box - poles	12	72	9	14 <sup>b</sup>	32
25	4-man litter-150 lb box - hand grips	12	72	9	17 <sup>b</sup>	36
26	4-man litter-150 lb box - handles	12	72	9	17 <sup>b</sup>	36
27	4-man litter-150 lb box - poles	12	72	9	17 <sup>b</sup>	36

<sup>a</sup>Data not collected.

<sup>b</sup>Load weight divided by the number of carriers.

<sup>c</sup>Adjustment for hand-carried loads:  $0.014 (\text{load wgt.})^2 (\text{speed})^2$ ; grade assumed to be 0%.

# Report 27

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
23	<u>0.20</u>	1.03	a	1.2	a	317 <sup>c</sup>	a	a
24	<u>0.20</u>	1.00	a	1.2	a	306 <sup>c</sup>	a	a
25	<u>0.20</u>	0.89	a	1.2	a	281 <sup>c</sup>	a	a
26	<u>0.20</u>	0.95	a	1.2	a	301 <sup>c</sup>	a	a
27	<u>0.20</u>	1.03	a	1.2	a	331 <sup>c</sup>	a	a

[concluded]

# Report 28

Date : 1965, July  
 Title : Energy expenditure of soldiers performing combat type activities  
 Author(s): Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Field  
 Subjects : 24 Infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Infantry litter bearer-jungle patrol	1	59	b	16	28
2	Rifleman in jungle patrol	2	69	b	15	21
3	Rifleman - jungle scout	1	68	b	15	22
4	RT0 operator - road march	1	66	b	34	51
5	M60 gunner - road march	1	92	b	31	35
6	M60 gunner - jungle patrol	1	63	b	23	37
7	Litter bearers - road march w/ 80kg casualty	2	84	b	22 <sup>c</sup>	27
8	Rifleman - in assault	1	56	b	21	39
9	81mm mortarman - jungle march	2	75	b	34	45
10	Company commander - trooping ridge positions	1	63	b	23	37
11	90mm recoilless rifleman - assault	1	74	b	35	47
12	81mm mortarman - road march	2	77	b	36	46
13	Rifleman - road march	1	80	b	22	28

<sup>a</sup>Data not collected.

<sup>b</sup>Included in load weight.

<sup>c</sup>Must not include 80kg litter load.

<sup>d</sup>Subject near collapse.

<sup>e</sup>One of the subjects near collapse.



# Report 28

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Resp. Vol. (L/Min)
					Obs.	Pred.			
1	a	a	a	a	234	a	a	a	15.9
2	a	a	a	a	274	a	a	a	23.4
3	a	a	a	a	328	a	a	a	26.5
4	a	a	a	a	293	a	a	a	17.4
5	a	a	a	a	328	a	a	a	23.6
6	a	a	a	a	352	a	a	a	26.0
7	a	a	a	a	468	a	a	a	33.5
8	a	a	a	a	482	a	a	a	35.7
9	a	a	a	a	502	a	a	a	35.9
10	a	a	a	a	509	a	a	a	36.8
11	a	a	a	a	530 <sup>d</sup>	a	a	a	51.3
12	a	a	a	a	632 <sup>e</sup>	a	a	a	37.2
13	a	a	a	a	265	a	a	a	20.0

# Report 29

Date : 1962, Jan.  
 Title : Energy cost of load carriage  
 Author(s): Goldman and Iampietro  
 Lab : Quartermaster Research and Engineering Command  
 Type : Treadmill  
 Subjects : 10 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Packboard - 9% grade - 10kg	5	76 <sup>b</sup>	3 <sup>c</sup>	10	17
2	" - " - 20kg	5	76 <sup>b</sup>	3 <sup>c</sup>	20	30
3	" - " - 30kg	5	76 <sup>b</sup>	3 <sup>c</sup>	30	43
4	" - 3% grade - 10kg	5	76 <sup>b</sup>	3 <sup>c</sup>	10	17
5	" - " - 20kg	5	76 <sup>b</sup>	3 <sup>c</sup>	20	30
6	" - " - 30kg	5	76 <sup>b</sup>	3 <sup>c</sup>	30	43
7	" - 6% grade - 10kg	5	76 <sup>b</sup>	3 <sup>c</sup>	10	17
8	" - " - 20kg	5	76 <sup>b</sup>	3 <sup>c</sup>	20	30
9	" - " - 30kg	5	76 <sup>b</sup>	3 <sup>c</sup>	30	43
10	" - 9% grade - 10kg	5	76 <sup>b</sup>	3 <sup>c</sup>	10	17
11	" - " - 20kg	5	76 <sup>b</sup>	3 <sup>c</sup>	20	30
12	" - " - 30kg	5	76 <sup>b</sup>	3 <sup>c</sup>	30	43
13	" - 3% grade - 10kg	5	76 <sup>b</sup>	3 <sup>c</sup>	10	17
14	" - " - 20kg	5	76 <sup>b</sup>	3 <sup>c</sup>	20	30
15	" - " - 30kg	5	76 <sup>b</sup>	3 <sup>c</sup>	30	43
16	" - 6% grade - 10kg	5	76 <sup>b</sup>	3 <sup>c</sup>	10	17
17	" - " - 20kg	5	76 <sup>b</sup>	3 <sup>c</sup>	20	30
18	" - " - 30kg	5	76 <sup>b</sup>	3 <sup>c</sup>	30	43
19	" - 9% grade - 10kg	5	76 <sup>b</sup>	3 <sup>c</sup>	10	17
20	" - " - 20kg	5	76 <sup>b</sup>	3 <sup>c</sup>	20	30
21	" - 3% grade - 10kg	5	76 <sup>b</sup>	3 <sup>c</sup>	10	17
22	" - " - 20kg	5	76 <sup>b</sup>	3 <sup>c</sup>	20	30

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for all ten subjects.

<sup>c</sup>Estimated (may have already been included by authors in subject weights).

# Report 29

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.81</u>	<u>0.67</u>	9	1.0	464	367	a	a
2	<u>1.81</u>	<u>0.67</u>	9	1.0	480	408	a	a
3	<u>1.81</u>	<u>0.67</u>	9	1.0	506	459	a	a
4	<u>3.02</u>	<u>1.12</u>	3	1.0	375	391	a	a
5	<u>3.02</u>	<u>1.12</u>	3	1.0	412	435	a	a
6	<u>3.02</u>	<u>1.12</u>	3	1.0	464	488	a	a
7	<u>3.02</u>	<u>1.12</u>	6	1.0	443	496	a	a
8	<u>3.02</u>	<u>1.12</u>	6	1.0	491	551	a	a
9	<u>3.02</u>	<u>1.12</u>	6	1.0	565	617	a	a
10	<u>3.02</u>	<u>1.12</u>	9	1.0	559	601	a	a
11	<u>3.02</u>	<u>1.12</u>	9	1.0	601	668	a	a
12	<u>3.02</u>	<u>1.12</u>	9	1.0	638	745	a	a
13	<u>4.21</u>	<u>1.56</u>	3	1.0	543	590	a	a
14	<u>4.21</u>	<u>1.56</u>	3	1.0	612	656	a	a
15	<u>4.21</u>	<u>1.56</u>	3	1.0	675	732	a	a
16	<u>4.21</u>	<u>1.56</u>	6	1.0	718	736	a	a
17	<u>4.21</u>	<u>1.56</u>	6	1.0	844	818	a	a
18	<u>4.21</u>	<u>1.56</u>	6	1.0	876	910	a	a
19	<u>4.21</u>	<u>1.56</u>	9	1.0	871	881	a	a
20	<u>4.21</u>	<u>1.56</u>	9	1.0	960	980	a	a
21	<u>4.83</u>	<u>1.79</u>	3	1.0	749	714	a	a
22	<u>4.83</u>	<u>1.79</u>	3	1.0	781	794	a	a

# Report 30

Date : 1965, June  
 Title : Development of a methodology for measuring infantry performance in marching...  
 Author(s): Gruber, Dunlap, DeNittis, Sanders, Perry, and Dixon  
 Lab : US Army General Equipment Test Activity  
 Type : Field  
 Subjects : Quartermaster and Airborne troops

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Flat track - 15 lb pack	9	a	a	7	a
2	" - 30 lb pack	9	a	a	14	a
3	" - 30 lb pack	7	a	a	14	a
4	" - 45 lb pack	7	a	a	20	a
5	" - 15 lb pack	8	a	a	7	a
6	" - 45 lb pack	8	a	a	20	a
7	Hilly track - 15 lb pack	20	a	a	7	a
8	" - 30 lb pack	20	a	a	14	a
9	Flat track - after obstacle course - 15 lb	10	a	a	7	a
10	Flat track - after obstacle course - 30 lb	10	a	a	14	a
11	Flat track - after obstacle course - 30 lb	13	a	a	14	a
12	Flat track - after obstacle course - 45 lb	13	a	a	20	a

<sup>a</sup>Data not collected.

<sup>b</sup>Net slope = 0%; course included many hills and valleys.

# Report 30

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>16.54</u>	1.62	0	1.1	a	a	a	a
2	<u>16.54</u>	1.61	0	1.1	a	a	a	a
3	<u>16.54</u>	1.66	0	1.1	a	a	a	a
4	<u>16.54</u>	1.49	0	1.1	a	a	a	a
5	<u>16.54</u>	1.63	0	1.1	a	a	a	a
6	<u>16.54</u>	1.49	0 <sup>b</sup>	1.1	a	a	a	a
7	<u>16.26</u>	1.65	0 <sup>b</sup>	1.1	a	a	a	a
8	<u>16.26</u>	1.54	0 <sup>b</sup>	1.1	a	a	a	a
9	<u>8.66</u>	1.69	0	1.1	a	a	a	a
10	<u>8.66</u>	1.60	0	1.1	a	a	a	a
11	<u>8.66</u>	1.64	0	1.1	a	a	a	a
12	<u>8.66</u>	1.56	0	1.1	a	a	a	a



# Report 31

Date : 1974, May  
 Title : Effect of terrain on the energy cost of walking with back loads...  
 Author(s): Haisman and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Field  
 Subjects : 8 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Blacktop road - backpack	8	75	7	20	36
2	" " - pushcart w/20kg	8	75	7	20	36
3	" " - pushcart w/60kg	8	75	7	60	89
4	" " - pushcart w/100kg	8	75	7	100	143
5	" " - backpack	8	75	7	20	36
6	" " - pushcart w/20kg	8	75	7	20	36
7	" " - pushcart w/60kg	8	75	7	60	89
8	" " - pushcart w/100kg	8	75	7	100	143
9	Dirt road - backpack	8	75	7	20	36
10	" " - pushcart w/20kg	8	75	7	20	36
11	" " - pushcart w/60kg	8	75	7	60	89
12	" " - pushcart w/100kg	8	75	7	100	143
13	" " - backpack	8	75	7	20	36
14	" " - pushcart w/20kg	8	75	7	20	36
15	" " - pushcart w/60kg	8	75	7	60	89
16	" " - pushcart w/100kg	8	75	7	100	143
17	Grass - backpack	8	75	7	20	36
18	" - pushcart w/20kg	8	75	7	20	36
19	" - pushcart w/60kg	8	75	7	60	89
20	" - pushcart w/100kg	8	75	7	100	143
21	" - backpack	8	75	7	20	36
22	" - pushcart w/20kg	8	75	7	20	36
23	" - pushcart w/60kg	8	75	7	60	89
24	" - pushcart w/100kg	8	75	7	100	143

<sup>a</sup>Data not collected.

<sup>b</sup>Expressed in report only as a change from rested values.

# Report 31

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	1.60	0.89	0	1.0	311	260	b	a
2	1.60	0.89	0	1.0	282	260	b	a
3	1.60	0.89	0	1.0	300	508	b	a
4	1.60	0.89	0	1.0	305	1079	b	a
5	2.41	1.34	0	1.0	418	414	b	a
6	2.41	1.34	0	1.0	391	414	b	a
7	2.41	1.34	0	1.0	410	722	b	a
8	2.41	1.34	0	1.0	425	1344	b	a
9	1.60	0.89	0	1.1	339	272	b	a
10	1.60	0.89	0	1.1	321	272	b	a
11	1.60	0.89	0	1.1	364	525	b	a
12	1.60	0.89	0	1.1	405	1091	b	a
13	2.41	1.34	0	1.1	455	441	b	a
14	2.41	1.34	0	1.1	445	441	b	a
15	2.41	1.34	0	1.1	505	760	b	a
16	2.41	1.34	0	1.1	547	1393	b	a
17	1.60	0.89	0	1.1	342	272	b	a
18	1.60	0.89	0	1.1	327	272	b	a
19	1.60	0.89	0	1.1	369	525	b	a
20	1.60	0.89	0	1.1	434	1091	b	a
21	2.41	1.34	0	1.1	461	441	b	a
22	2.41	1.34	0	1.1	467	441	b	a
23	2.41	1.34	0	1.1	547	760	b	a
24	2.41	1.34	0	1.1	608	1393	b	a

## Report 32

Date : 1974  
 Title : Physiological evaluations of armoured vests in hot-wet and hot-dry climates  
 Author(s): Haisman and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 8 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Standard armor - hot/wet climate	8	76	b	26	34
2	" " - hot/dry "	8	76	b	26	34
3	Lightwgt. armor - hot/wet "	8	76	b	26	34
4	" " - hot/dry "	8	76	b	26	34
5	No armor, control - hot/wet "	8	76	b	26	34
6	" " - hot/dry "	8	76	b	26	34

<sup>a</sup>Data not collected.

<sup>b</sup>Included in load weight.

## Report 33

Date : 1972, August  
 Title : Energy cost of pushing handcarts  
 Author(s): Haisman, Winsmann, and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Field and treadmill  
 Subjects : 7 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Blacktop road - mail cart	7	79	7	50	73
2	" " - large garden cart	7	79	7	50	73
3	" " - small garden cart	7	79	7	50	73
4	" " - golf cart	7	79	7	50	73
5	Treadmill - mail cart	7	79	7	50	73
6	" - large garden cart	7	79	7	50	73
7	" - small garden cart	7	79	7	50	73
8	" - golf cart	7	79	7	50	73

<sup>a</sup>Data not collected.

# Report 32

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent. (L/Min)
					Obs.	Pred.			
1	6.72	1.12	0	1.0	377	330	147	a	27.8
2	6.72	1.12	0	1.0	369	330	153	a	27.5
3	6.72	1.12	0	1.0	371	330	132	a	26.8
4	6.72	1.12	0	1.0	369	330	145	a	26.9
5	6.72	1.12	0	1.0	373	330	134	a	26.8
6	6.72	1.12	0	1.0	358	330	135	a	25.3

# Report 33

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	2.81	1.56	0	1.0	474	757	a	a
2	2.81	1.56	0	1.0	496	757	a	a
3	2.81	1.56	0	1.0	530	757	a	a
4	2.81	1.56	0	1.0	549	757	a	a
5	2.81	1.56	0	1.0	482	757	a	a
6	2.81	1.56	0	1.0	489	757	a	a
7	2.81	1.56	0	1.0	519	757	a	a
8	2.81	1.56	0	1.0	553	757	a	a

# Report 34

Date : 1957, October  
 Title : Performance tests for the evaluation of Army combat packs  
 Author(s): Hale and Karpovich  
 Lab : Quartermaster Research and Engineering Center  
 Type : Field  
 Subjects : 24 male students

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	24	c	3 <sup>b</sup>	0	a
2	27 lb US standard pack	24	c	3 <sup>b</sup>	12	a
3	" T53-8 pack	24	c	3 <sup>b</sup>	12	a
4	" UK-Z2 pack	24	c	3 <sup>b</sup>	12	a

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Body weights ranged from 56 kg (124 lbs) to 94 kg (208 lbs).

# Report 35

Date : 1958, June  
 Title : Evaluation of 50 & 80 lb ammunition containers...  
 Author(s): Hicks and McCain  
 Lab : US Army Ordnance Human Engineering Laboratory  
 Type : Field  
 Subjects : 30 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	50 lb ammo can - one hand carry	10	69	6 <sup>b</sup>	23	42
2	50 lb ammo can - any style but one hand	10	69	6 <sup>b</sup>	23	42
3	Two 50 lb cans - one in each hand	10	74	6 <sup>b</sup>	45	69
4	80 lb ammo can - one hand carry	10	73	6 <sup>b</sup>	36	58

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from photographs in the report.

<sup>c</sup>Includes adjustments for hand-carried loads:  $.014(\text{load wgt})^2(\text{speed})^2$ .



# Report 34

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>0.02</u>	4.86	0	1.1	a	a	a	a
2	<u>0.02</u>	4.60	0	1.1	a	a	a	a
3	<u>0.02</u>	4.58	0	1.1	a	a	a	a
4	<u>0.02</u>	4.54	0	1.1	a	a	a	a

# Report 35

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>0.14</u>	1.54	0	1.0	a	515 <sup>c</sup>	a	a
2	<u>0.14</u>	1.61	0	1.0	a	550 <sup>c</sup>	a	a
3	<u>0.14</u>	1.51	0	1.0	a	740 <sup>c</sup>	a	a
4	<u>0.14</u>	0.79	0	1.0	a	309 <sup>c</sup>	a	a

# Report 36

Date : 1970, November  
 Title : Energy cost of "hard work"  
 Author(s): Hughes and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 12 male volunteers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	12	68	4	0	5
2	Weighted vest - 20 kg	12	68	4	20	35
3	" " - 30 kg	12	68	4	30	49
4	Weighted vest and belt - 40 kg	12	68	4	40	64
5	" " - 50 kg	12	68	4	50	79
6	" " - 60 kg	12	68	4	60	94

<sup>a</sup>Data not collected.

<sup>b</sup>Subjects were told to complete 6.4 km or 80 min., whichever came first.

# Report 36

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>6.40</u>	2.25	0	1.0	683	649	a	a
2	<u>6.40</u>	1.75	0	1.0	545	548	a	a
3	b	1.58	0	1.0	532	535	a	a
4	b	1.39	0	1.0	521	520	a	a
5	b	1.17	0	1.0	459	506	a	a
6	b	1.00	0	1.0	449	534	a	a

# Report 37

Date : 1979, May  
 Title : Load bearing systems test - draft report  
 Author(s): Individual Soldier and Battlefield Environment Directorate  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 30 male airborne soldiers and 30 male marines

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Phase I - fighting load only	60	72 <sup>b</sup>	10	13	32
2	Phase II - fighting load only	60	72 <sup>b</sup>	10	13	32
3	85lb - ALICE pack frame	36	72	10	52	86
4	" - improved ALICE frame	36	72	10	53	87
5	" - M1961 rucksack	36	72	10	52	86
6	" - 82nd packboard	36	72	10	52	87
7	" - Canadian pack frame	36	72	10	51	85
8	" - LOCO pack	36	72	10	51	85
9	65lb - ALICE pack frame	36	72	10	43	74
10	" - improved pack frame	36	72	10	43	74
11	" - M1961 rucksack	36	72	10	42	73
12	" - 82nd packboard	36	72	10	43	74
13	" - Canadian pack frame	36	72	10	42	73
14	" - LOCO pack	36	72	10	42	72
15	40lb - ALICE pack frame	36	72	10	32	58
16	" - improved ALICE frame	36	72	10	32	59
17	" - M1961 rucksack	36	72	10	31	57
18	" - 82nd packboard	36	72	10	32	58
19	" - Canadian pack frame	36	72	10	31	57
20	" - LOCO pack	36	72	10	30	56
21	" - ALICE pack frame	36	72	10	32	58
22	" - improved ALICE frame	36	72	10	32	59
23	" - M1961 rucksack	36	72	10	31	57
24	" - 82nd packboard	36	72	10	32	58
25	" - Canadian pack frame	36	72	10	31	57
26	" - LOCO pack	36	72	10	30	56
27	Control - assault load	36	72	10	4	19

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for 36 subjects.

<sup>c</sup>Minimum speed (all subjects completed the course in under 2 hours).

<sup>d</sup>Subjects completed the march but times were not taken.

<sup>e</sup>Trials discontinued because "the 85 lb load...and the (10km) movement were debilitating

<sup>f</sup>The 179 ft. dash was part of an obstacle course.

## Report 37

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	12.00	1.67 <sup>c</sup>	0	1.0	a	525	a	a
2	20.00	d	0	1.0	a	a	a	a
3	10.00	e	0	1.0	a	a	a	a
4	10.00	e	0	1.0	a	a	a	a
5	10.00	e	0	1.0	a	a	a	a
6	10.00	e	0	1.0	a	a	a	a
7	10.00	e	0	1.0	a	a	a	a
8	10.00	e	0	1.0	a	a	a	a
9	5.00	d	0	1.0	a	a	a	a
10	5.00	d	0	1.0	a	a	a	a
11	5.00	d	0	1.0	a	a	a	a
12	5.00	d	0	1.0	a	a	a	a
13	5.00	d	0	1.0	a	a	a	a
14	5.00	d	0	1.0	a	a	a	a
15	5.00	d	0	1.0	a	a	a	a
16	5.00	d	0	1.0	a	a	a	a
17	5.00	d	0	1.0	a	a	a	a
18	5.00	d	0	1.0	a	a	a	a
19	5.00	d	0	1.0	a	a	a	a
20	5.00	d	0	1.0	a	a	a	a
21	0.06	2.81 <sup>f</sup>	0	1.1	a	1671	a	a
22	0.06	2.75 <sup>f</sup>	0	1.1	a	1608	a	a
23	0.06	2.75 <sup>f</sup>	0	1.1	a	1591	a	a
24	0.06	2.77 <sup>f</sup>	0	1.1	a	1629	a	a
25	0.06	2.79 <sup>f</sup>	0	1.1	a	1633	a	a
26	0.06	2.93 <sup>f</sup>	0	1.1	a	1764	a	a
27	0.06	3.75 <sup>f</sup>	0	1.1	a	2110	a	a



# Report 38

Date : 1980, April  
 Title : Human factors engineering assessment - squad automatic weapon system  
 Author(s): Individual Soldier and Battlefield Environment Directorate  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 21 male marines

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	M16A1	21	72	10	11	29
2	M16A1(AR)	21	72	10	20	41
3	SAWS I	21	72	10	20	41
4	SAWS II	21	72	10	21	43
5	SAWS III	21	72	10	20	42
6	SAWS IV	21	72	10	24	47
7	M16A1(AR)	21	72	10	20	41
8	SAWS I	21	72	10	20	41
9	SAWS II	21	72	10	21	43
10	SAWS III	21	72	10	20	42
11	SAWS IV	21	72	10	24	47

<sup>a</sup>Data not collected.

<sup>b</sup>This distance is the sum of the inter-obstacle dashes on an obstacle course.

<sup>c</sup>Includes adjustment for hand carried load:  $.014(\text{load wgt})^2(\text{speed})^2$ ,  
 M16A1(AR) (3.43 kg), SAWS I (6.82 kg), SAWS II (9.67 kg) SAWS III (9.89 kg),  
 SAWS IV (12.11 kg).

Report 38

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>3.47</u>	a	0	1.3	a	a	a	a
2	<u>3.47</u>	a	0	1.3	a	a	a	a
3	<u>3.47</u>	a	0	1.3	a	a	a	a
4	<u>3.47</u>	a	0	1.3	a	a	a	a
5	<u>3.47</u>	a	0	1.3	a	a	a	a
6	<u>3.47</u>	a	0	1.3	a	a	a	a
7	<u>0.19</u> <sup>b</sup>	3.45	0	1.1	a	2297 <sup>c</sup>	a	a
8	<u>0.19</u> <sup>b</sup>	3.20	0	1.1	a	1996 <sup>c</sup>	a	a
9	<u>0.19</u> <sup>b</sup>	3.07	0	1.1	a	1875 <sup>c</sup>	a	a
10	<u>0.19</u> <sup>b</sup>	3.09	0	1.1	a	1871 <sup>c</sup>	a	a
11	<u>0.19</u> <sup>b</sup>	2.94	0	1.1	a	1807 <sup>c</sup>	a	a

# Report 39

Date : 1971  
 Title : The physiological cost of carrying loads in temperate and hot environments  
 Author(s): Kamon and Belding  
 Lab : Department of Occupational Health, Univ. of Pittsburgh  
 Type : Treadmill  
 Subjects : 3 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load - 4km/hr - level	3	77	1 <sup>b</sup>	0	1
2	Control - no load - 4km/hr - 4% grade	3	77	1 <sup>b</sup>	0	1
3	Control - no load - 5km/hr - level	3	77	1 <sup>b</sup>	0	1
4	Control - no load - 5km/hr - 4% grade	3	77	1 <sup>b</sup>	0	1
5	10kg carton in hands - 4km/hr - level	3	77	1 <sup>b</sup>	10	1
6	10kg carton in hands - 4km/hr - 4% grade	3	77	1 <sup>b</sup>	10	1
7	10kg carton in hands - 5km/hr - level	3	77	1 <sup>b</sup>	10	1
8	10kg carton in hands - 5km/hr - 4% grade	3	77	1 <sup>b</sup>	10	1
9	15kg carton in hands - 4km/hr - level	3	77	1 <sup>b</sup>	15	1
10	15kg carton in hands - 4km/hr - 4% grade	3	77	1 <sup>b</sup>	15	1
11	15kg carton in hands - 5km/hr - level	3	77	1 <sup>b</sup>	15	1
12	15kg carton in hands - 5km/hr - 4% grade	3	77	1 <sup>b</sup>	15	1
13	20kg carton in hands - 4km/hr - level	3	77	1 <sup>b</sup>	20	1
14	20kg carton in hands - 4km/hr - 4% grade	3	77	1 <sup>b</sup>	20	1
15	20kg carton in hands - 5km/hr - level	3	77	1 <sup>b</sup>	20	1
16	20kg carton in hands - 5km/hr 4% grade	3	77	1 <sup>b</sup>	20	1

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Include addition for hand-held loads:  $0.014 (\text{Load Wgt})^2 (\text{Speed})^2$ .

# Report 39

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Step Freq. No./Min.
					Obs.	Pred.			
1	<u>0.33</u>	<u>1.11</u>	0	1.0	288	260	a	0.84	99
2	<u>0.33</u>	<u>1.11</u>	4	1.0	366	381	a	1.07	96
3	<u>0.42</u>	<u>1.39</u>	0	1.0	349	342	a	1.02	110
4	<u>0.42</u>	<u>1.39</u>	4	1.0	456	493	a	1.33	109
5	<u>0.33</u>	<u>1.11</u>	0	1.0	355	284 <sup>c</sup>	a	1.04	105
6	<u>0.33</u>	<u>1.11</u>	4	1.0	457	421 <sup>c</sup>	a	1.34	102
7	<u>0.42</u>	<u>1.39</u>	0	1.0	466	377 <sup>c</sup>	a	1.36	112
8	<u>0.42</u>	<u>1.39</u>	4	1.0	620	549 <sup>c</sup>	a	1.81	113
9	<u>0.33</u>	<u>1.11</u>	0	1.0	401	300 <sup>c</sup>	a	1.17	107
10	<u>0.33</u>	<u>1.11</u>	4	1.0	479	444 <sup>c</sup>	a	1.40	101
11	<u>0.42</u>	<u>1.39</u>	0	1.0	479	400 <sup>c</sup>	a	1.40	119
12	<u>0.42</u>	<u>1.39</u>	4	1.0	556	581 <sup>c</sup>	a	1.63	117
13	<u>0.33</u>	<u>1.11</u>	0	1.0	480	319 <sup>c</sup>	a	1.40	111
14	<u>0.33</u>	<u>1.11</u>	4	1.0	492	471 <sup>c</sup>	a	1.44	107
15	<u>0.42</u>	<u>1.39</u>	0	1.0	524	426 <sup>c</sup>	a	1.53	123
16	<u>0.42</u>	<u>1.39</u>	4	1.0	657	617 <sup>c</sup>	a	1.92	120

# Report 40

Date : 1961, May  
 Title : Oxygen uptake and pulse rate while running with undetermined and determined stride...  
 Author(s): Knuttgen  
 Lab : Laboratory for the Theory of Gymnastics, Denmark  
 Type : Treadmill  
 Subjects : 2 male runners

Line No.	Test Condition/Method of Carry	No.	W(kg)	Unif.	Load	%BW
1	Undetermined stride - 9.00 km/hr	2	74	1 <sup>b</sup>	0	1
2	" " - 9.75 km/hr	2	74	1 <sup>b</sup>	0	1
3	" " - 10.50 km/hr	2	74	1 <sup>b</sup>	0	1
4	" " - 11.25 km/hr	2	74	1 <sup>b</sup>	0	1
5	" " - 12.00 km/hr	2	74	1 <sup>b</sup>	0	1
6	" " - 12.75 km/hr	2	74	1 <sup>b</sup>	0	1
7	" " - 13.50 km/hr	2	74	1 <sup>b</sup>	0	1
8	" " - 14.25 km/hr	2	74	1 <sup>b</sup>	0	1
9	" " - 15.00 km/hr	2	74	1 <sup>b</sup>	0	1
10	" " - 15.75 km/hr	2	74	1 <sup>b</sup>	0	1
11	" " - 16.50 km/hr	2	74	1 <sup>b</sup>	0	1
12	Determined Stride - 9.00 km/hr	2	74	1 <sup>b</sup>	0	1
13	" " - 9.33 km/hr	2	74	1 <sup>b</sup>	0	1
14	" " - 9.67 km/hr	2	74	1 <sup>b</sup>	0	1
15	" " - 10.00 km/hr	2	74	1 <sup>b</sup>	0	1
16	" " - 10.33 km/hr	2	74	1 <sup>b</sup>	0	1
17	" " - 10.67 km/hr	2	74	1 <sup>b</sup>	0	1
18	" " - 11.00 km/hr	2	74	1 <sup>b</sup>	0	1
19	" " - 11.33 km/hr	2	74	1 <sup>b</sup>	0	1
20	" " - 11.67 km/hr	2	74	1 <sup>b</sup>	0	1

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.



Report 40

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Stride Length %
					Obs.	Pred.			
1	1.50	2.50	0	1.0	a	814	140	2.46	77
2	1.63	2.71	0	1.0	a	937	141	2.61	83
3	1.75	2.92	0	1.0	a	1070	145	2.75	90
4	1.88	3.13	0	1.0	a	1213	148	2.91	95
5	2.00	3.33	0	1.0	a	1359	160	3.11	102
6	2.13	3.54	0	1.0	a	1521	168	3.36	111
7	2.25	3.75	0	1.0	a	1693	176	3.62	115
8	2.38	3.96	0	1.0	a	1875	179	3.87	125
9	2.50	4.17	0	1.0	a	2067	183	3.93	129
10	2.63	4.38	0	1.0	a	2269	188	4.17	140
11	2.75	4.58	0	1.0	a	2471	190	4.24	145
12	1.50	2.50	0	1.0	a	814	140	2.46	77
13	1.56	2.59	0	1.0	a	866	144	2.52	77
14	1.61	2.69	0	1.0	a	925	147	2.65	77
15	1.67	2.78	0	1.0	a	980	154	2.83	77
16	1.72	2.87	0	1.0	a	1038	164	3.02	77
17	1.78	2.96	0	1.0	a	1097	166	3.28	77
18	1.83	3.06	0	1.0	a	1164	175	3.50	77
19	1.89	3.15	0	1.0	a	1227	180	3.78	77
20	1.95	3.24	0	1.0	a	1292	188	3.99	77

# Report 41

Date : 1980, April  
 Title : ...Portability of the special atomic demolition munition (SADM)  
 Author(s): Kostakis, Carlock, and Hall  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 21 marines

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - fighting load only	21	71	11	0	15
2	Backpack - ALICE 2 w/ SADM	21	71	11	29	56
3	" - experimental ALICE 2 w/ SADM	21	71	11	33	62
4	Backpack H911 bag w/ SADM	21	71	11	30	58

<sup>a</sup>Data not collected.

# Report 41

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	<u>1.60</u>	2.38	0	1.1	a	877	a	a
2	<u>1.60</u>	1.97	0	1.1	a	888	a	a
3	<u>1.60</u>	1.88	0	1.1	a	865	a	a
4	<u>1.60</u>	1.94	0	1.1	a	877	a	a

# Report 42

Date : 1956, April  
 Title : Use of heart rate as an index of work output  
 Author(s): LeBlanc  
 Lab : Defense Research Northern Laboratory, Canada  
 Type : Field  
 Subjects : 22 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Walking - 3.1 mph	6	a	a	0	a
2	" - 3.6 mph	6	a	a	0	a
3	" - 4.1 mph	6	a	a	0	a
4	" - 4.5 mph	6	a	a	0	a
5	Running - 5.1 mph	6	a	a	0	a
6	" - 5.9 mph	6	a	a	0	a
7	" - 7.5 mph	6	a	a	0	a
8	" - 9.5 mph	6	a	a	0	a
9	Running - 5.5 mph - 0.25 miles	6	a	a	0	a
10	" - " - 0.5 miles	6	a	a	0	a
11	" - " - 1.0 miles	6	a	a	0	a
12	" - " - 1.5 miles	6	a	a	0	a
13	" - " - 2.5 miles	6	a	a	0	a
14	Walking 4.1 mph - 35 lb load - 50°F	a	a	a	16	a
15	Walking 4.1 mph - 35 lb load - 70°F	a	a	a	16	a
16	36 lb back load - 140 lb toboggan-snowshoes	7	74 <sup>b</sup>	11	16 <sup>c</sup>	37
17	36 lb back load - 185 lb toboggan-snowshoes	9	74 <sup>b</sup>	11	16 <sup>c</sup>	37
18	Snowshoes - 2.3 mph	18	74	a	0	a
19	" - 2.85 mph	18	74	a	0	a
20	" - 3.4 mph	18	74	a	0	a

<sup>a</sup>Data not collected.

<sup>b</sup>Weight for 16-subject group.

<sup>c</sup>Not including the weight of the toboggans.

Report 42

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.61</u>	<u>1.39</u>	0	1.0	a	a	84	a
2	<u>1.61</u>	<u>1.61</u>	0	1.0	a	a	91	a
3	<u>1.61</u>	<u>1.83</u>	0	1.0	a	a	97	a
4	<u>1.61</u>	<u>2.01</u>	0	1.0	a	a	105	a
5	<u>1.61</u>	<u>2.28</u>	0	1.0	a	a	119	a
6	<u>1.61</u>	<u>2.64</u>	0	1.0	a	a	147	a
7	<u>1.61</u>	<u>3.35</u>	0	1.0	a	a	160	a
8	<u>1.61</u>	<u>4.25</u>	0	1.0	a	a	174	a
9	<u>0.40</u>	<u>2.46</u>	0	1.0	a	a	122	a
10	<u>0.80</u>	<u>2.46</u>	0	1.0	a	a	129	a
11	<u>1.61</u>	<u>2.46</u>	0	1.0	a	a	137	a
12	<u>2.41</u>	<u>2.46</u>	0	1.0	a	a	147	a
13	<u>4.02</u>	<u>2.46</u>	0	1.0	a	a	154	a
14	<u>3.22</u>	<u>1.83</u>	0	1.0	a	a	119	a
15	<u>3.22</u>	<u>1.83</u>	0	1.0	a	a	135	a
16	<u>29.29</u>	<u>0.96</u>	0	1.3	a	a	137	a
17	<u>29.29</u>	<u>0.87</u>	0	1.3	a	a	126	a
18	<u>0.80</u>	<u>1.03</u>	0	1.3	a	a	102	a
19	<u>0.80</u>	<u>1.27</u>	0	1.3	a	a	114	a
20	<u>0.80</u>	<u>1.52</u>	0	1.3	a	a	125	a

# Report 43

Date : 1969, June  
 Title : Effect of individual variation on the upper limit of prescriptive zone of climates  
 Author(s): Lind  
 Lab : US Army Natick Laboratory  
 Type : Treadmill  
 Subjects : 128 male soldiers

Line No.	Test Condition/Method of Carry	No.	W(kg)	Unif.	Load	%BW
1	Effective temperature 21°c	26	70 <sup>d</sup>	1 <sup>b</sup>	0	1
2	" " 27°c	25	70 <sup>d</sup>	1 <sup>b</sup>	0	1
3	" " 29°c	19	70 <sup>d</sup>	1 <sup>b</sup>	0	1
4	" " 31°c	25	70 <sup>d</sup>	1 <sup>b</sup>	0	1

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Not all subjects were able to complete the three hours.

<sup>d</sup>Stated in report as weight of "standard" man.

<sup>e</sup>Pulse rate for those who completed the 3 hrs.



# Report 43

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Ss failing 3 hrs %
					Obs.	Pred.			
1	<u>15.49</u> <sup>c</sup>	<u>1.56</u>	0	1.0	a	364	137 <sup>e</sup>	a	0
2	<u>15.49</u> <sup>c</sup>	<u>1.56</u>	0	1.0	a	364	140 <sup>e</sup>	a	4
3	<u>15.49</u> <sup>c</sup>	<u>1.56</u>	0	1.0	a	364	143 <sup>e</sup>	a	32
4	<u>15.49</u> <sup>c</sup>	<u>1.56</u>	0	1.0	a	364	151 <sup>e</sup>	a	64

# Report 44

Date : 1970  
 Title : Influence of age and daily duration of exposure to responses of men to work in heat  
 Author(s): Lind, Humphreys, Collins, Foster, and Sweetland  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 12 males (6 of mean age 27, 6 of mean age 47)

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Effective temp. 20°C - younger men	6	71	4 <sup>b</sup>	0	6
2	Effective temp. 20°C - older men	6	74	4 <sup>b</sup>	0	5
3	Effective temp. 26°C - younger men	6	71	4 <sup>b</sup>	0	6
4	Effective temp. 26°C - older men	6	74	4 <sup>b</sup>	0	5
5	Effective temp. 28.5°C - younger men	6	71	4 <sup>b</sup>	0	6
6	Effective temp. 28.5°C - older men	6	74	4 <sup>b</sup>	0	5
7	Effective temp. 29.5°C - younger men	6	71	4 <sup>b</sup>	0	6
8	Effective temp. 29.5°C - older men	6	74	4 <sup>b</sup>	0	5
9	Effective temp. 30.5°C - younger men	6	71	4 <sup>b</sup>	0	6
10	Effective temp. 30.5°C - older men	6	74	4 <sup>b</sup>	0	5

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

Report 44

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Rectal Temp. °C
					Obs.	Pred.			
1	<u>4.02</u>	<u>1.34</u>	0	1.0	a	309	101	a	37.4
2	<u>4.02</u>	<u>1.34</u>	0	1.0	a	322	97	a	37.7
3	<u>4.02</u>	<u>1.34</u>	0	1.0	a	309	105	a	37.5
4	<u>4.02</u>	<u>1.34</u>	0	1.0	a	322	100	a	37.7
5	<u>4.02</u>	<u>1.34</u>	0	1.0	a	309	110	a	37.5
6	<u>4.02</u>	<u>1.34</u>	0	1.0	a	322	108	a	37.7
7	<u>4.02</u>	<u>1.34</u>	0	1.0	a	309	115	a	37.6
8	<u>4.02</u>	<u>1.34</u>	0	1.0	a	322	117	a	37.9
9	<u>4.02</u>	<u>1.34</u>	0	1.0	a	309	122	a	37.8
10	<u>4.02</u>	<u>1.34</u>	0	1.0	a	322	124	a	38.0

# Report 45

Date : 1968  
 Title : Cardiovascular responses to holding and carrying weights by hand and by...harness  
 Author(s): Lind and McNicol  
 Lab : Indiana University Cardiopulmonary Laboratory  
 Type : Field and laboratory  
 Subjects : 10 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	20 kg in right hand - 2.5 minutes	10	a	a	20	a
2	20 kg in left hand - " "	10	a	a	20	a
3	20 kg in each hand - " "	10	a	a	40	a
4	20 kg " " " - " "	10	a	a	40	a
5	40 kg shoulder harness - 15 minutes	10	a	a	40	a
6	5 kg in right hand - 5 minutes	8	a	a	5	a
7	10 kg in right hand - 5 minutes	8	a	a	10	a
8	15 kg " " " - 2.5 minutes	8	a	a	15	a
9	20 kg " " " - " "	8	a	a	20	a
10	10 kg in left hand - 5 minutes	8	a	a	10	a
11	10 kg in each hand - " "	8	a	a	20	a
12	40 kg shoulder harness - 5 minutes	8	a	a	40	a
13	80 kg " " " - " "	8	a	a	80	a
14	120 kg shoulder harness - 5 minutes	8	a	a	120	a
15	82 kg stretcher - march to exhaustion	10	a	a	41 <sup>d</sup>	a
16	82 kg stretcher with harness - 15 minute march	10	a	a	41 <sup>e</sup>	a

<sup>a</sup>Data not collected.

<sup>b</sup>Rested value taken as 85 beats per minute, from Figure 3 in Report 45.

<sup>c</sup>Rested mean blood pressure taken as 95, from Figure 3 in Report 45.

<sup>d</sup>Weight per carrier.

<sup>e</sup>Weight of shoulder harness not included; weight per carrier.

Report 45

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Est. Mean Blood Press.
					Obs.	Pred.			
1	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	103 <sup>b</sup>	a	129 <sup>c</sup>
2	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	106 <sup>b</sup>	a	143 <sup>c</sup>
3	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	103 <sup>b</sup>	a	144 <sup>c</sup>
4	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	102	a	171
5	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	92	a	120
6	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	90	a	106
7	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	95	a	125
8	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	a	a	a
9	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	102	a	138
10	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	98	a	125
11	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	99	a	120
12	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	80	a	103
13	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	91	a	120
14	<u>0.00</u>	<u>0.00</u>	0	1.0	a	a	104	a	150
15	0.17	<u>0.89</u>	0	1.0	a	a	145	a	143
16	<u>0.80</u>	<u>0.89</u>	0	1.0	a	a	138	a	98

# Report 46

Date : 1971  
 Title : Time course of heart rate, ventilation, and  $\text{VO}_2$  during laboratory and field exercise  
 Author(s): Maksud, Coutts, and Hamilton  
 Lab : University of Wisconsin - Milwaukee  
 Type : Treadmill and Field  
 Subjects : 15 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	7 mph - treadmill	15 <sup>b</sup>	74	2 <sup>c</sup>	0	3
2	" - track	15 <sup>b</sup>	74	2 <sup>c</sup>	0	3
3	10 mph - treadmill	15 <sup>b</sup>	74	2 <sup>c</sup>	0	3
4	" - track	15 <sup>b</sup>	74	2 <sup>c</sup>	0	3
5	12 mph - treadmill	15 <sup>b</sup>	74	2 <sup>c</sup>	0	3
6	" - track	15 <sup>b</sup>	74	2 <sup>c</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Equipment failures prevented complete data collection from some subjects.

<sup>c</sup>Estimated from textual details.

<sup>d</sup>Estimated from graphs.



Report 46

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent
					Obs.	Pred.			(L/Min)
1	<u>0.38</u>	<u>3.13</u>	0	1.0	a	1228	156	2.80 <sup>d</sup>	74
2	<u>0.38</u>	<u>3.13</u>	0	1.0	a	1228	160 <sup>d</sup>	2.90 <sup>d</sup>	69
3	<u>0.54</u>	<u>4.47</u>	0	1.0	a	2389	180 <sup>d</sup>	3.40 <sup>d</sup>	113
4	<u>0.54</u>	<u>4.47</u>	0	1.0	a	2389	181 <sup>d</sup>	3.50 <sup>d</sup>	104
5	<u>0.64</u>	<u>5.36</u>	0	1.0	a	3386	185	3.70 <sup>d</sup>	150
6	<u>0.64</u>	<u>5.36</u>	0	1.0	a	3386	185	4.00 <sup>d</sup>	142

# Report 47

Date : 1966  
 Title : Physical work capacity as influenced by age  
 Author(s): Malhotra, Ramaswamy, Dua, and Sengupta  
 Lab : Defense Institute of Physiology and Allied Sciences, India  
 Type : Field  
 Subjects : 879 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	2 mile loaded run - 18 to 30 years	605	60	2 <sup>b</sup>	15	28
2	2 mile loaded run - 31 to 37 years	170	60	2 <sup>b</sup>	15	28
3	2 mile loaded run - 38 to 43 years	89	60	2 <sup>b</sup>	15	28
4	200 yd fireman's lift - 18 to 30 years	605	60	2 <sup>b</sup>	60 <sup>c</sup>	103
5	200 yd fireman's lift - 31 to 37 years	170	60	2 <sup>b</sup>	60 <sup>c</sup>	103
6	200 yd fireman's lift - 38 to 43 years	89	60	2 <sup>b</sup>	60 <sup>c</sup>	103
7	Endurance Run - 18 to 30 years	605	60	2 <sup>b</sup>	0	3
8	" " - 31 to 37 years	170	60	2 <sup>b</sup>	0	3
9	" " - 38 to 43 years	89	60	2 <sup>b</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.

<sup>c</sup>Each subject carried "another person of his own weight."

Report 47

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	<u>3.22</u>	3.27	0	1.0	a	1337	a	a
2	<u>3.22</u>	3.09	0	1.0	a	1205	a	a
3	<u>3.22</u>	2.86	0	1.0	a	1047	a	a
4	<u>0.18</u>	2.47	0	1.0	a	1467	a	a
5	<u>0.18</u>	2.26	0	1.0	a	1285	a	a
6	<u>0.18</u>	2.15	0	1.0	a	1196	a	a
7	<u>5.58</u>	<u>3.33</u>	0	1.0	a	1121	a	a
8	<u>3.74</u>	<u>3.33</u>	0	1.0	a	1121	a	a
9	<u>2.60</u>	<u>3.33</u>	0	1.0	a	1121	a	a

# Report 48

Date : 1962  
 Title : Influence of body weight on energy expenditure  
 Author(s): Malhotra, Ramaswamy, and Ray  
 Lab : Defence Science Laboratory, India  
 Type : Field  
 Subjects : 58 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Marching	58	64	b	0	a

<sup>a</sup>Data not included.

<sup>b</sup>Included in body weight.

<sup>c</sup>Clothing weight of 2 kg assumed.

# Report 49

Date : 1965  
 Title : Carrying of school bags by children  
 Author(s): Malhotra and Sen Gupta  
 Lab : Defense Institute of Physiology and Allied Sciences, India  
 Type : Field  
 Subjects : 2 adult males, 10 males aged 9 to 15

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - standing - no load	2	a	a	4	a
2	Rucksack	2	a	a	4	a
3	Shoulder - slung	2	a	a	4	a
4	Hand-carried	2	a	a	4	a
5	Control - marching - no load	10	a	a	3	a
6	Rucksack	10	a	a	3	a
7	Low back	10	a	a	3	a
8	Shoulder - slung	10	a	a	3	a
9	Hand-carried	10	a	a	3	a

<sup>a</sup>Data not collected.

# Report 48

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts) Obs.	Pred.	Heart Rate	VO <sub>2</sub> (L/Min)
1	a	<u>1.56</u>	0	1.0	326	327 <sup>c</sup>	a	0.95

# Report 49

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts) Obs.	Pred.	Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent. (L/Min)
1	<u>1.01</u>	<u>1.12</u>	0	1.1	a	a	85	0.24	8.2
2	<u>1.01</u>	<u>1.12</u>	0	1.1	a	a	96	0.59	13.0
3	<u>1.01</u>	<u>1.12</u>	0	1.1	a	a	97	0.62	13.5
4	<u>1.01</u>	<u>1.12</u>	0	1.1	a	a	105	0.73	15.4
5	a	<u>1.12</u>	0	1.1	a	a	95	0.29	7.7
6	a	<u>1.12</u>	0	1.1	a	a	100	0.40	9.1
7	a	<u>1.12</u>	0	1.1	a	a	104	0.44	10.1
8	a	<u>1.12</u>	0	1.1	a	a	109	0.49	11.5
9	a	<u>1.12</u>	0	1.1	a	a	120	0.54	12.9

# Report 50

Date : 1965  
 Title : The kinetics of the oxygen consumption at the onset of muscular exercise...  
 Author(s): Margaria, Mangili, Cuttica, and Cerretelli  
 Lab : Institute of Human Physiology, University of Milan, Italy  
 Type : Treadmill  
 Subjects : 4 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	12km/hr - 5% grade	4	75	2 <sup>b</sup>	0	3
2	" - 8% grade	4	75	2 <sup>b</sup>	0	3
3	" - 15% grade	4	75	2 <sup>b</sup>	0	3
4	15km/hr - 13% grade	4	75	2 <sup>b</sup>	0	3
5	" - 18% grade	4	75	2 <sup>b</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.



Report 50

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	0.40	<u>3.33</u>	5	1.0	a	1842	a	3.45
2	0.18	<u>3.33</u>	8	1.0	a	2111	a	3.14
3	0.15	<u>3.33</u>	15	1.0	a	2740	a	3.64
4	0.17	<u>4.17</u>	13	1.0	a	3582	a	3.90
5	0.13	<u>4.17</u>	18	1.0	a	4144	a	3.93

# Report 51

Date : 1963, May  
 Title : A comparison of energy expenditure when carrying different weights with "Hip Pack" ...  
 Author(s): Martorano, Jackson, and Malone  
 Lab : US Naval Medical Field Research Laboratory  
 Type : Treadmill  
 Subjects : 9 male marines

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	9	77	6 <sup>b</sup>	0	8
2	Hip Pack - 30 lbs	9	77	6 <sup>b</sup>	14	26
3	" - 50 lbs	9	77	6 <sup>b</sup>	23	38
4	" - 70 lbs	9	77	6 <sup>b</sup>	32	49
5	Packboard - 30 lbs	9	77	6 <sup>b</sup>	14	26
6	" - 50 lbs	9	77	6 <sup>b</sup>	23	38
7	" - 70 lbs	9	77	6 <sup>b</sup>	32	49
8	Haversack - 30 lbs	9	77	6 <sup>b</sup>	14	26
9	" - 50 lbs	9	77	6 <sup>b</sup>	23	38
10	" - 70 lbs	9	77	6 <sup>b</sup>	32	49
11	Control - no load	9	77	6 <sup>b</sup>	0	8
12	70 lbs - on back - Hip Pack	9	77	6 <sup>b</sup>	32	49
13	" - on hips - Hip Pack	9	77	6 <sup>b</sup>	32	49

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Five of nine subjects were unable to complete full march of 1.88 km (20 min).

<sup>d</sup>Approximation stated in text.

Report 51

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	0.94	1.56	1.5	1.0	427	487	112	a
2	1.88	1.56	1.5	1.0	528	562	121	a
3	1.88	1.56	1.5	1.0	554	619	136	a
4	1.88	1.56	1.5	1.0	611	686	150	a
5	1.88	1.56	1.5	1.0	516	562	128	a
6	1.88	1.56	1.5	1.0	536	619	134	a
7	1.88	1.56	1.5	1.0	663	686	143	a
8	1.88	1.56	1.5	1.0	477	562	129	a
9	1.88	1.56	1.5	1.0	581	619	127	a
10	1.88	1.56	1.5	1.0	576	686	146	a
11	0.94	1.56	1.5	1.0	426	487	a	a
12	1.88	1.56	1.5	1.0	599	686	a	a
13	1.88 <sup>c</sup>	1.56	1.5	1.0	726	686	170 <sup>d</sup>	a

# Report 52

Date : 1965, March  
 Title : Backpacking the Davy Crockett weapon system: effect of carrying very heavy loads  
 Author(s): McGinnis, Tambe, and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill and Field  
 Subjects : 9 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Tripod - pack x	3	72 <sup>b</sup>	5	34	53
2	" - packboard	3	72 <sup>b</sup>	5	31	50
3	Missile - pack x	3	72 <sup>b</sup>	5	35	56
4	" - packboard	3	72 <sup>b</sup>	5	37	58
5	Gun - pack x	3	72 <sup>b</sup>	5	43	67
6	" - packboard	3	72 <sup>b</sup>	5	41	64
7	Control - light load	9	72	5	0	6
8	Tripod - pack x	9	72	5	34	53
9	" - packboard	9	72	5	31	50
10	Missile - pack x	9	72	5	35	56
11	" - packboard	9	72	5	37	58
12	Gun - pack x	9	72	5	43	67
13	" - packboard	9	72	5	41	64

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for all 9 subjects.

# Report 53

Date : 1960, October  
 Title : Cardiorespiratory responses during prolonged exercise  
 Author(s): Michael, Hutton, and Horvath  
 Lab : Division of Research, Lankenau Hospital, Philadelphia  
 Type : Treadmill  
 Subjects : 3 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	3.0 mph - 3% grade	3	77	2 <sup>b</sup>	0	3
2	3.0 mph - 6% grade	1	69	2 <sup>b</sup>	0	3
3	3.5 mph - 6% grade	1	87	2 <sup>b</sup>	0	2
4	3.0 mph - 8.6% grade	1	76	2 <sup>b</sup>	0	3
5	3.5 mph - 12% grade	2	73	2 <sup>b</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.

# Report 52

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Rectal Temp °C
					Obs.	Pred.			
1	4.03	1.12	0	1.0	451	382	123	a	37.3
2	4.03	1.12	0	1.0	452	365	121	a	37.4
3	4.03	1.12	0	1.0	522	388	130	a	37.7
4	4.03	1.12	0	1.0	515	400	124	a	37.7
5	4.03	1.12	0	1.0	520	440	141	a	38.1
6	4.03	1.12	0	1.0	514	426	134	a	38.0
7	3.43	1.72	0	1.2	a	519	a	a	a
8	3.43	1.24	0	1.2	a	474	a	a	38.6
9	3.43	1.28	0	1.2	a	481	a	a	38.8
10	3.43	1.24	0	1.2	a	487	a	a	38.5
11	3.43	1.22	0	1.2	a	491	a	a	38.5
12	3.43	1.08	0	1.2	a	417	a	a	38.7
13	3.43	1.12	0	1.2	a	471	a	a	38.8

# Report 53

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	38.62	1.34	3	1.0	a	440	118	1.42
2	38.62	1.34	6	1.0	a	495	124	1.70
3	45.06	1.56	6	1.0	a	747	149	2.28
4	38.62	1.34	8.6	1.0	a	639	140	2.17
5	15.49	1.56	12	1.0	a	875	162	2.48

# Report 54

Date : 1979, September  
 Title : Self-pacing during sustained, repetitive exercise  
 Author(s): Myles, Eclache, and Beaury  
 Lab : Defence and Civil Institute of Environmental Medicine, Canada  
 Type : Field  
 Subjects : 9 male Canadians and 25 French infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Preliminary study - 10% load	9	69	4 <sup>d</sup>	a	10
2	" " - 40% load	9	69	4 <sup>d</sup>	a <sup>e</sup>	40
3	Exercise Fastball - Day 1	25	69	4 <sup>d</sup>	24 <sup>e</sup>	41
4	" " - Day 2	25	69	4 <sup>d</sup>	23 <sup>e</sup>	39
5	" " - Day 3	25	69	4 <sup>d</sup>	22 <sup>e</sup>	38
6	" " - Day 4	25	69	4 <sup>d</sup>	22 <sup>e</sup>	38
7	" " - Day 5	25	69	4 <sup>d</sup>	22 <sup>e</sup>	38
8	" " - Day 6	25	69	4 <sup>d</sup>	22 <sup>e</sup>	38

<sup>a</sup>Data not collected.

<sup>b</sup>Data for 10% load and 40% load combined.

<sup>c</sup>Mean heart rate for all 6 days.

<sup>d</sup>Arbitrary value assigned by this author.

<sup>e</sup>Mean load weights: different (but unspecified) weights assigned to different subjects.

<sup>f</sup>Computed by the authors.

<sup>g</sup>Computed from estimated energy expenditure.



# Report 54

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>5.00</u>	a	0	1.0	a	a	121 <sup>b</sup>	1.48 <sup>b</sup>
2	<u>5.00</u>	a	0	1.0	a	a <sup>f</sup>	121 <sup>b</sup>	1.48 <sup>b</sup>
3	<u>34.00</u>	1.67	a	a	a	520 <sup>f</sup>	118 <sup>c</sup>	1.51 <sup>g</sup>
4	<u>34.00</u>	1.49	a	a	a	429 <sup>f</sup>	118 <sup>c</sup>	1.22 <sup>g</sup>
5	<u>34.00</u>	1.53	a	a	a	443 <sup>f</sup>	118 <sup>c</sup>	1.27 <sup>g</sup>
6	<u>30.00</u>	1.52	a	a	a	438 <sup>f</sup>	118 <sup>c</sup>	1.27 <sup>g</sup>
7	<u>30.50</u>	1.53	a	a	a	444 <sup>f</sup>	118 <sup>c</sup>	1.31 <sup>g</sup>
8	<u>38.50</u>	1.61	a	a	a	480 <sup>f</sup>	118 <sup>c</sup>	1.39 <sup>g</sup>

# Report 55

Date : 1978  
 Title : Cardio-respiratory performance of porters carrying loads on a treadmill  
 Author(s): Nag, Sen, and Roy  
 Lab : Work Physiology and Ergonomics Laboratory, Calcutta University  
 Type : Treadmill  
 Subjects : 4 male Indians, accustomed to high altitudes and heavy loads

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	4	53	1 <sup>b</sup>	0	4
2	Back load w/ forehead strap-60kg	4	53	1 <sup>b</sup>	60	117
3	" " " -80kg	4	53	1 <sup>b</sup>	80	155
3	" " " -100kg	4	53	1 <sup>b</sup>	100	192
4	Control - no load	4	53	1 <sup>b</sup>	0	4
5	Back load w/ forehead strap-60kg	4	53	1 <sup>b</sup>	60	117
6	" " " -80kg	4	53	1 <sup>b</sup>	80	155
7	" " " -100kg	4	53	1 <sup>b</sup>	100	192

<sup>a</sup>Data not collected.

<sup>b</sup>Calculated from textual details.

<sup>c</sup>Estimated by authors by the formula:  $0.163 ((\text{body wgt} + \text{load wgt}) \times (\text{m/min}))$ .

# Report 56

Date : 1947, February  
 Title : The relation between the weight of the soldier, load carried, distance marched...  
 Author(s): Newsome and Singh  
 Lab : Operational Research Section, India  
 Type : Field  
 Subjects : no information available

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Backpack - 20 lb	a	a	a	9	a
2	" - 50 lb	a	a	a	23	a
3	" - 20 lb	a	a	a	9	a
4	" - 50 lb	a	a	a	23	a

<sup>a</sup>Data not collected.

Note: The data from this study obtained from Ref. 108.

# Report 55

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Pulm. Vent. (L/Min)
					Obs.	Pred.			
1	<u>0.53</u>	<u>0.89</u>	0	1.0	465 <sup>c</sup>	144	116	1.17	27.0
2	<u>0.53</u>	<u>0.89</u>	0	1.0	989 <sup>c</sup>	517	141	2.17	45.1
3	<u>0.53</u>	<u>0.89</u>	0	1.0	1164 <sup>c</sup>	865	146	2.55	51.2
4	<u>0.53</u>	<u>0.89</u>	0	1.0	1335 <sup>c</sup>	1381	154	3.60	58.7
5	<u>0.62</u>	<u>1.03</u>	0	1.0	541 <sup>c</sup>	165	117	1.08	27.7
6	<u>0.62</u>	<u>1.03</u>	0	1.0	1154 <sup>c</sup>	563	148	2.22	47.2
7	<u>0.62</u>	<u>1.03</u>	0	1.0	1358 <sup>c</sup>	919	153	2.84	52.7
8	<u>0.62</u>	<u>1.03</u>	0	1.0	1565 <sup>c</sup>	1443	162	3.81	60.2

# Report 56

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>8.05</u>	<u>1.61</u>	a	a	a	a	a	a
2	<u>8.05</u>	<u>1.61</u>	a	a	a	a	a	a
3	<u>11.27</u>	<u>1.61</u>	a	a	a	a	a	a
4	<u>11.27</u>	<u>1.61</u>	a	a	a	a	a	a

# Report 57

Date : 1976, November  
 Title : Predicting energy expenditure with loads while standing or walking very slowly  
 Author(s): Pandolf, Givoni, and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Indoor laboratory  
 Subjects : 16 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	32kg backpack - 0.2 mps	6	78	2 <sup>b</sup>	32	44
2	" " - 0.4 mps	6	78	2 <sup>b</sup>	32	44
3	" " - 0.6 mps	6	78	2 <sup>b</sup>	32	44
4	" " - 0.8 mps	6	78	2 <sup>b</sup>	32	44
5	" " - 1.0 mps	6	78	2 <sup>b</sup>	32	44
6	40kg backpack - 0.2 mps	6	78	2 <sup>b</sup>	40	54
7	" " - 0.4 mps	6	78	2 <sup>b</sup>	40	54
8	" " - 0.6 mps	6	78	2 <sup>b</sup>	40	54
9	" " - 0.8 mps	6	78	2 <sup>b</sup>	40	54
10	" " - 1.0 mps	6	78	2 <sup>b</sup>	40	54
11	50kg backpack - 0.2 mps	6	78	2 <sup>b</sup>	50	67
12	" " - 0.4 mps	6	78	2 <sup>b</sup>	50	67
13	" " - 0.6 mps	6	78	2 <sup>b</sup>	50	67
14	" " - 0.8 mps	6	78	2 <sup>b</sup>	50	67
15	" " - 1.0 mps	6	78	2 <sup>b</sup>	50	67
16	Control - no load - standing	10	78	2 <sup>b</sup>	0	3
17	10kg backpack - standing	10	78	2 <sup>b</sup>	10	15
18	30kg backpack - standing	10	78	2 <sup>b</sup>	30	41
19	50kg backpack - standing	10	78	2 <sup>b</sup>	50	67

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated - normal street clothes assumed.

Report 57

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	0.18	0.20	0	1.0	241	166	a	a
2	0.36	0.40	0	1.0	288	186	a	a
3	0.54	0.60	0	1.0	328	220	a	a
4	0.72	0.80	0	1.0	379	267	a	a
5	0.90	1.00	0	1.0	445	328	a	a
6	0.18	0.20	0	1.0	258	194	a	a
7	0.36	0.40	0	1.0	308	215	a	a
8	0.54	0.60	0	1.0	352	251	a	a
9	0.72	0.80	0	1.0	406	302	a	a
10	0.90	1.00	0	1.0	476	367	a	a
11	0.18	0.20	0	1.0	280	240	a	a
12	0.36	0.40	0	1.0	334	264	a	a
13	0.54	0.60	0	1.0	381	303	a	a
14	0.72	0.80	0	1.0	439	359	a	a
15	0.90	1.00	0	1.0	516	428	a	a
16	0.00	0.00	0	1.0	106	117	a	a
17	0.00	0.00	0	1.0	109	121	a	a
18	0.00	0.00	0	1.0	124	154	a	a
19	0.00	0.00	0	1.0	144	233	a	a

# Report 58

Date : 1976  
 Title : Metabolic energy expenditure and terrain coefficients for walking on snow  
 Author(s): Pandolf, Haisman, and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Field and Treadmill  
 Subjects : 10 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Snow march - 1.5 mph	6	75 <sup>b</sup>	9	0	12
2	Snow march - 2.5 mph	6	75 <sup>b</sup>	9	0	12

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for 10 subjects.

<sup>c</sup>Two subjects failed to complete 15 minute march.

<sup>d</sup>All subjects were unable to complete 15 minute march.

<sup>e</sup>Estimated from Figure 1 of Report 58.



# Report 58

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	c	<u>0.67</u>	0	4.4	803 <sup>e</sup>	364	a	3.20
2	0.50 <sup>d</sup>	<u>1.12</u>	0	4.1	767 <sup>e</sup>	763	189	3.52

# Report 59

Date : 1977, March  
 Title : Human factors engineering assessment of the infiltrator vest combat system VII  
 Author(s): Personal Equipment and Life Support System Team  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 31 airborne infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Rifleman - ALICE	26	71 <sup>b</sup>	8	18	37
2	" - IVCS	26	71 <sup>b</sup>	8	20	39
3	Grenadier - ALICE	26	71 <sup>b</sup>	8	21	41
4	" - IVCS	26	71 <sup>b</sup>	8	22	43
5	M60 gunner - ALICE	26	71 <sup>b</sup>	8	23	44
6	" - IVCS	26	71 <sup>b</sup>	8	24	46
7	Assistant M60 gunner - ALICE	26	71 <sup>b</sup>	8	33	58
8	" " - IVCS	26	71 <sup>b</sup>	8	35	61
9	Dragon gunner - ALICE	26	71 <sup>b</sup>	8	26	48
10	" " - IVCS	26	71 <sup>b</sup>	8	27	50
11	Radio telephone operator - ALICE	26	71 <sup>b</sup>	8	25	47
12	Radio telephone operator - IVCS	26	71 <sup>b</sup>	8	27	50

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for all 31 subjects.

<sup>c</sup>All subjects completed the marching course but no times were recorded.

# Report 59

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>3.78</u>	c	0	1.3	a	a	a	a
2	<u>3.78</u>	c	0	1.3	a	a	a	a
3	<u>3.78</u>	c	0	1.3	a	a	a	a
4	<u>3.78</u>	c	0	1.3	a	a	a	a
5	<u>3.78</u>	c	0	1.3	a	a	a	a
6	<u>3.78</u>	c	0	1.3	a	a	a	a
7	<u>3.78</u>	c	0	1.3	a	a	a	a
8	<u>3.78</u>	c	0	1.3	a	a	a	a
9	<u>3.78</u>	c	0	1.3	a	a	a	a
10	<u>3.78</u>	c	0	1.3	a	a	a	a
11	<u>3.78</u>	c	0	1.3	a	a	a	a
12	<u>3.78</u>	c	0	1.3	a	a	a	a

# Report 60

Date : 1976, February  
 Title : Squad automatic weapon system (SAWS) human engineering evaluation  
 Author(s): Personnel Systems and Infantry Systems Teams  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 10 infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Rifleman Control	10	69	3	11 <sup>b</sup>	21
2	Rifleman - 200 round ammo box <sup>b</sup>	10	69	3	15 <sup>b</sup>	27
3	Rifleman - 3 100 round ammo boxes <sup>b</sup>	10	69	3	18 <sup>b</sup>	30
4	MSAW gunner - 200 rounds on weapon	10	69	3	17	29
5	PSAW gunner - 200 rounds on weapon	10	69	3	15	27
6	RSAW gunner - 200 rounds on weapon	10	69	3	15	27
7	M60 gunner - 100 rounds on weapon	10	69	3	19	32
8	MSAW gunner - 400 rounds (200 on sling)	10	69	3	21	36
9	PSAW gunner - 400 rounds (200 on sling)	10	69	3	20	33
10	RSAW gunner - 400 rounds (200 on sling)	10	69	3	19	33
11	M60 gunner - 300 rounds (200 on sling)	10	69	3	25	41
12	MSAW gunner - 400 rounds (300 on sling)	10	69	3	22	37
13	PSAW gunner - 400 rounds (300 on sling)	10	69	3	20	34
14	RSAW gunner - 400 rounds (300 on sling)	10	69	3	20	33

<sup>a</sup>Data not collected.

<sup>b</sup>A slight variation in weight among types of ammo boxes not reported here.

<sup>c</sup>All subjects completed the marching course but no times were recorded.

# Report 60

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>3.47</u>	c	0	1.3	a	a	a	a
2	<u>3.47</u>	c	0	1.3	a	a	a	a
3	<u>3.47</u>	c	0	1.3	a	a	a	a
4	<u>3.47</u>	c	0	1.3	a	a	a	a
5	<u>3.47</u>	c	0	1.3	a	a	a	a
6	<u>3.47</u>	c	0	1.3	a	a	a	a
7	<u>3.47</u>	c	0	1.3	a	a	a	a
8	<u>3.47</u>	c	0	1.3	a	a	a	a
9	<u>3.47</u>	c	0	1.3	a	a	a	a
10	<u>3.47</u>	c	0	1.3	a	a	a	a
11	<u>3.47</u>	c	0	1.3	a	a	a	a
12	<u>3.47</u>	c	0	1.3	a	a	a	a
13	<u>3.47</u>	c	0	1.3	a	a	a	a
14	<u>3.47</u>	c	0	1.3	a	a	a	a

# Report 61

Date : 1981, January  
 Title : Mechanical energy analyses of the human during load carriage on a treadmill  
 Author(s): Pierrynowski, Norman, and Winter  
 Lab : Department of Kinesiology, University of Waterloo, Ontario  
 Type : Treadmill  
 Subjects : 6 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	6	72	2 <sup>b</sup>	0	3
2	Backpack - 15.16kg	6	72	2 <sup>b</sup>	15	24
3	" - 19.30kg	6	72	2 <sup>b</sup>	19	29
4	" - 22.65kg	6	72	2 <sup>b</sup>	23	35
5	" - 28.63kg	6	72	2 <sup>b</sup>	29	43
6	" - 33.85kg	6	72	2 <sup>b</sup>	34	50
7	Control - no load - standing	6	72	2 <sup>b</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated.



# Report 61

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Mech. Energy
					Obs.	Pred.			(Watts)
1	<u>1.11</u>	<u>1.54</u>	0	1.0	355	371	a	a	167
2	<u>1.11</u>	<u>1.54</u>	0	1.0	437	435	a	a	193
3	<u>1.11</u>	<u>1.54</u>	0	1.0	473	455	a	a	229
4	<u>1.11</u>	<u>1.54</u>	0	1.0	504	476	a	a	219
5	<u>1.11</u>	<u>1.54</u>	0	1.0	547	513	a	a	226
6	<u>1.11</u>	<u>1.54</u>	0	1.0	620	546	a	a	240
7	<u>0.00</u>	<u>0.00</u>	0	1.0	100	108	a	a	a

# Report 62

Date : 1979, January  
 Title : Energy expenditure while standing or walking slowly uphill or downhill with loads  
 Author(s): Pimental and Pandolf  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 8 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Standing; + 10% grade; 20kg load	8	79	3	20	29
2	" ; " ; 40kg load	8	79	3	40	55
3	" ; + 25% grade; 20kg load	8	79	3	20	29
4	" ; " ; 40kg load	8	79	3	40	55
5	Walking; + 10% grade; 20kg load	8	79	3	20	29
6	" ; " ; 40kg load	8	79	3	40	55
7	" ; - 10% grade; 20kg load	8	79	3	20	29
8	" ; " ; 40kg load	8	79	3	40	55
9	" ; + 10% grade; 20kg load	8	79	3	20	29
10	" ; " ; 40kg load	8	79	3	40	55

<sup>a</sup>Data not collected.

<sup>b</sup>Formula unable to predict for negative grades.

# Report 63

Date : 1960  
 Title : Comparison of energy expenditure during treadmill walking and floor walking  
 Author(s): Ralston  
 Lab : Biomechanics Laboratory, Univ. of California  
 Type : Treadmill  
 Subjects : 4 males, 2 females

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Treadmill	6	70 <sup>b</sup>	2 <sup>c</sup>	0	3
2	Floor	6	70 <sup>b</sup>	2 <sup>c</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Assuming weights of 75 kg for males and 62 kg for females.

<sup>c</sup>Estimated from textual details.

# Report 62

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	0.00	0.00	10.0	1.0	113	132	81	a
2	0.00	0.00	10.0	1.0	132	183	89	a
3	0.00	0.00	25.0	1.0	123	132	82	a
4	0.00	0.00	25.0	1.0	136	183	83	a
5	1.08	0.90	10.0	1.0	550	559	124	a
6	1.08	0.90	10.0	1.0	691	697	146	a
7	1.08	0.90	-10.0	1.0	253	b	93	a
8	1.08	0.90	-10.0	1.0	325	b	104	a
9	0.60	0.50	10.0	1.0	385	346	102	a
10	0.60	0.50	10.0	1.0	462	441	116	a

# Report 63

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	0.98	1.63	0	1.0	333	392	a	a
2	0.98	1.63	0	1.0	334	392	a	a

# Report 64

Date : 1960  
 Title : The eosinopenia of physical exercise  
 Author(s): Redfearn  
 Lab : Army Operational Research Group, Surrey, England  
 Type : Field and Treadmill  
 Subjects : 19 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	24 km march - 30 kg load	6	a	a	30	a
2	" - 15 kg load	6	a	a	15	a
3	Treadmill - Control-no exercise	6	a	a	0	a
4	" - 1/2 hour march	6	a	a	a	a
5	" - 1 hour march	6	a	a	a	a
6	" - 1 1/2 hour march	6	a	a	a	a
7	" - 2 hour march	6	a	a	a	a
8	Control - no march	4	a	a <sup>e</sup>	0	a
9	12 km march - 30 kg load	4	a	2 <sup>e</sup>	30	a
10	24 km march - no load	4	a	a	0	a
11	" " - 30 kg load	4	a	a	30	a
12	Control - no march	3	a	a	0	a
13	Treadmill - march to exhaustion	3	a	a	0	a

<sup>a</sup>Data not collected.

<sup>b</sup>Approximate; not including 17% rest stops.

<sup>c</sup>WBC = white blood cells.

<sup>d</sup>Estimated from graphs.

<sup>e</sup>Estimated from textual details.

<sup>f</sup>Not including 17% rest stops.

<sup>g</sup>Data for one subject - typical of other two.

# Report 64

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Post/Pre Ratio WBC Count <sup>c</sup>
					Obs.	Pred.			
1	24.00	1.67 <sup>b</sup>	0	1.1	a	a	a	a	40 <sup>d</sup>
2	24.00	1.67 <sup>b</sup>	0	1.1	a	a	a	a	40 <sup>d</sup>
3	0.00	0.00	0	1.0	a	a	a	a	93
4	3.00 <sup>d</sup>	1.70 <sup>d</sup>	7	1.0	a	a	160	a	78
5	5.75 <sup>d</sup>	1.60 <sup>d</sup>	7	1.0	a	a	160	a	62
6	8.00 <sup>d</sup>	1.50 <sup>d</sup>	7	1.0	a	a	160	a	49
7	11.00 <sup>d</sup>	1.50 <sup>d</sup>	7	1.0	a	a	160	a	30 <sup>d</sup>
8	0.00	1.60 <sup>f</sup>	0	1.0	a	a	a	a	100 <sup>d</sup>
9	12.00	1.60 <sup>f</sup>	0	1.0	a	a	a	a	89 <sup>d</sup>
10	24.00	1.60 <sup>f</sup>	0	1.0	a	a	a	a	72 <sup>d</sup>
11	24.00	1.60 <sup>f</sup>	0	1.0	a	a	a	a	42 <sup>d</sup>
12	0.00	0.00	0	1.0	a	a	a	a	76 <sup>g</sup>
13	45.00 <sup>g</sup>	1.78	2.5	1.0	a	a	a	a	8 <sup>g</sup>

# Report 65

Date : 1955, January  
 Title : A comparative physiological field trial of four types of personal load carriage equipment  
 Author(s): Reid, Renbourn, and Draper  
 Lab : Clothing and Equipment Physiological Research Establishment, Great Britain  
 Type : Field and Treadmill  
 Subjects : no information available

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Treadmill - assault jerkin	a	a	a	23	a
2	" - rucksack	a	a	a	24	a
3	Treadmill - Z.2 pack	a	a	a	24	a
4	Field - assault jerkin	a	a	a	23	a
5	" - rucksack	a	a	a	24	a
6	" - Z.2 pack	a	a	a	24	a

<sup>a</sup>Data not collected.

<sup>b</sup>Subjects marched as many as 28 hours.

Note: The data for this study obtained from Ref. 108.

# Report 66

Date : 1979  
 Title : An acceptable workload for Indian workers  
 Author(s): Saha, Datta, Banerjee, and Narayane  
 Lab : Industrial Physiology Division, Central Labor Institute, India  
 Type : Treadmill  
 Subjects : 5 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	20% of $VO_2$ max	5	55	2 <sup>b</sup>	0	4
2	28% of "	4	55	2 <sup>b</sup>	0	4
3	36% of "	5	55	2 <sup>b</sup>	0	4
4	50% of "	3	52	2 <sup>b</sup>	0	4
5	62% of "	3	53	2 <sup>b</sup>	0	4
6	70% of "	3	52	2 <sup>b</sup>	0	4

<sup>a</sup>Data not collected.

<sup>b</sup>Assumed.

<sup>c</sup>Derived from equations in Table 5. of Report 66.



# Report 65

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	<u>2.41</u>	<u>1.34</u>	a	a	a	a	a	a
2	<u>2.41</u>	<u>1.34</u>	a	a	a	a	a	a
3	<u>2.41</u>	<u>1.34</u>	a	a	a	a	a	a
4	b	a	a	a	a	a	a	a
5	b	a	a	a	a	a	a	a
6	b	a	a	a	a	a	a	a

# Report 66

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	a	a	a	1.0	175 <sup>c</sup>	a	96	0.50
2	a	a	a	1.0	229 <sup>c</sup>	a	100	0.66
3	a	a	a	1.0	313 <sup>c</sup>	a	118	0.90
4	a	a	a	1.0	432 <sup>c</sup>	a	140	1.25
5	a	a	a	1.0	541 <sup>c</sup>	a	156	1.56
6	a	a	a	1.0	628 <sup>c</sup>	a	172	1.81

# Report 67

Date : 1961, February  
 Title : Human factors engineering evaluation of the 4.2" mortar, T201  
 Author(s): Short Range Direct Fire Weapons Branch Personnel  
 Lab : US Army Ordnance Human Engineering Laboratory  
 Type : Field  
 Subjects : 12 infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	2-man litter - Baseplate	12	73 <sup>b</sup>	3 <sup>c</sup>	39	58
2	" - Tube	12	73 <sup>b</sup>	3 <sup>c</sup>	38	56
3	" - Bipod	12	73 <sup>b</sup>	3 <sup>c</sup>	51	74

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for US Army soldiers (Ref. 131).

<sup>c</sup>Standard Army fatigues assumed.

<sup>d</sup>Includes adjustment for hand-carried loads:  $0.014 (\text{load wgt})^2 (\text{speed})^2$ .

Report 67

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
1	<u>0.18</u>	1.09	0	1.1	a	923 <sup>d</sup>	a	a
2	<u>0.18</u>	1.14	0	1.1	a	957 <sup>d</sup>	a	a
3	<u>0.18</u>	0.69	0	1.1	a	705 <sup>d</sup>	a	a

# Report 68

Date : 1969, November  
 Title : Energy cost of loads carried on the head, hands, or feet  
 Author(s): Soule and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 10 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	10	70	4	0	6
2	" "	10	70	4	0	6
3	" "	10	70	4	0	6
4	4kg in each hand	10	70	4	8	17
5	" "	10	70	4	8	17
6	" "	10	70	4	8	17
7	7kg in each hand	10	70	4	14	26
8	" "	10	70	4	14	26
9	" "	10	70	4	14	26
10	14kg on the head	10	70	4	14	26
11	" "	10	70	4	14	26
12	" "	10	70	4	14	26
13	6kg on each foot	10	70	4	12	23
14	" "	10	70	4	12	23
15	" "	10	70	4	12	23

<sup>a</sup>Data not collected.

<sup>b</sup>Includes adjustment for hand-carried loads:  $0.014 (\text{load wgt})^2 (\text{speed})^2$ .

<sup>c</sup>Formula not able to predict for loads carried on the feet.

Report 68

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.33</u>	<u>1.11</u>	0	1.0	a	241	a	0.76
2	<u>1.60</u>	<u>1.33</u>	0	1.0	a	300	a	0.93
3	<u>1.87</u>	<u>1.56</u>	0	1.0	a	373	a	1.12
4	<u>1.33</u>	<u>1.11</u>	0	1.0	a	264 <sup>b</sup>	a	0.89
5	<u>1.60</u>	<u>1.33</u>	0	1.0	a	331 <sup>b</sup>	a	1.06
6	<u>1.87</u>	<u>1.56</u>	0	1.0	a	414 <sup>b</sup>	a	1.35
7	<u>1.33</u>	<u>1.11</u>	0	1.0	a	285 <sup>b</sup>	a	1.05
8	<u>1.60</u>	<u>1.33</u>	0	1.0	a	358 <sup>b</sup>	a	1.25
9	<u>1.87</u>	<u>1.56</u>	0	1.0	a	449 <sup>b</sup>	a	1.53
10	<u>1.33</u>	<u>1.11</u>	0	1.0	a	277	a	0.93
11	<u>1.60</u>	<u>1.33</u>	0	1.0	a	348	a	1.11
12	<u>1.87</u>	<u>1.56</u>	0	1.0	a	435	a	1.40
13	<u>1.33</u>	<u>1.11</u>	0	1.0	a	c	a	1.28
14	<u>1.60</u>	<u>1.33</u>	0	1.0	a	c	a	1.81
15	<u>1.87</u>	<u>1.56</u>	0	1.0	a	c	a	2.28

# Report 69

Date : 1972, May  
 Title : Terrain coefficients for energy cost prediction  
 Author(s): Soule and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Field and Treadmill  
 Subjects : 8 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Blacktop road - 2.5 mph - 8kg backpack	8	74	b	8	11
2	Blacktop road - 2.5 mph - 20kg backpack	8	74	b	20	27
3	Blacktop road - 2.5 mph - 30kg backpack	8	74	b	30	41
4	Blacktop road - 3.5 mph - 8kg backpack	8	74	b	8	11
5	Blacktop road - 3.5 mph - 20kg backpack	8	74	b	20	27
6	Blacktop road - 3.5 mph - 30kg backpack	8	74	b	30	41
7	Dirt road - 2.5 mph - 8kg backpack	8	74	b	8	11
8	Dirt road - 2.5 mph - 20kg backpack	8	74	b	20	27
9	Dirt road - 2.5 mph - 30kg backpack	8	74	b	30	41
10	Dirt road - 3.5 mph - 8kg backpack	8	74	b	8	11
11	Dirt road - 3.5 mph - 20kg backpack	8	74	b	20	27
12	Dirt road - 3.5 mph - 30kg backpack	8	74	b	30	41
13	Light brush - 2.5 mph - 8kg backpack	8	74	b	8	11
14	Light brush - 2.5 mph - 20kg backpack	8	74	b	20	27
15	Light brush - 2.5 mph - 30 kg backpack	8	74	b	30	41
16	Light brush - 3.5 mph - 8kg backpack	8	74	b	8	11
17	Light brush - 3.5 mph - 20kg backpack	8	74	b	20	27
18	Light brush - 3.5 mph - 30kg backpack	8	74	b	30	41



# Report 69

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.98</u>	<u>1.10</u>	0	1.0	215	262	a	a
2	<u>1.98</u>	<u>1.10</u>	0	1.0	298	295	a	a
3	<u>1.98</u>	<u>1.10</u>	0	1.0	290	334	a	a
4	<u>2.79</u>	<u>1.55</u>	0	1.0	377	408	a	a
5	<u>2.79</u>	<u>1.55</u>	0	1.0	329	463	a	a
6	<u>2.79</u>	<u>1.55</u>	0	1.0	488	520	a	a
7	<u>1.98</u>	<u>1.10</u>	0	1.1	288	277	a	a
8	<u>1.98</u>	<u>1.10</u>	0	1.1	352	312	a	a
9	<u>1.98</u>	<u>1.10</u>	0	1.1	418	353	a	a
10	<u>2.79</u>	<u>1.55</u>	0	1.1	418	438	a	a
11	<u>2.79</u>	<u>1.55</u>	0	1.1	416	497	a	a
12	<u>2.79</u>	<u>1.55</u>	0	1.1	519	557	a	a
13	<u>1.98</u>	<u>1.10</u>	0	1.2	311	292	a	a
14	<u>1.98</u>	<u>1.10</u>	0	1.2	438	329	a	a
15	<u>1.98</u>	<u>1.10</u>	0	1.2	478	372	a	a
16	<u>2.79</u>	<u>1.55</u>	0	1.2	471	468	a	a
17	<u>2.79</u>	<u>1.55</u>	0	1.2	515	531	a	a
18	<u>2.79</u>	<u>1.55</u>	0	1.2	567	595	a	a

[continued]

# Report 69 [continued]

Date : 1972, May  
 Title : Terrain coefficients for energy cost prediction  
 Author(s): Soule and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Field and Treadmill  
 Subjects : 8 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
19	Heavy brush - 1.5 mph - 8kg backpack	8	74	b	8	11
20	Heavy brush - 1.5 mph - 20kg backpack	8	74	b	20	27
21	Heavy brush - 1.5 mph - 30kg backpack	8	74	b	30	41
22	Heavy brush - 2.5 mph - 8kg backpack	8	74	b	8	11
23	Heavy brush - 2.5 mph - 20kg backpack	8	74	b	20	27
24	Heavy brush - 2.5 mph - 20kg backpack	8	74	b	30	41
25	Swampy bog - 1.5 mph - 8kg backpack	8	74	b	8	11
26	Swampy bog - 1.5 mph - 20kg backpack	8	74	b	20	27
27	Swampy bog - 1.5 mph - 30kg backpack	8	74	b	30	41
28	Swampy bog - 2.5 mph - 8kg backpack	8	74	b	8	11
29	Swampy bog - 2.5 mph - 20kg backpack	8	74	b	20	27
30	Swampy bog - 2.5 mph - 30kg backpack	8	74	b	30	41
31	Loose sand - 1.5 mph - 8kg backpack	8	74	b	8	11
32	Loose sand - 1.5 mph - 20kg backpack	8	74	b	20	27
33	Loose sand - 1.5 mph - 30kg backpack	8	74	b	30	41
34	Loose sand - 2.5 mph - 8kg backpack	8	74	b	8	11
35	Loose sand - 2.5 mph - 20kg backpack	8	74	b	20	27
36	Loose sand - 2.5 mph - 30kg backpack	8	74	b	30	41

# Report 69

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
19	<u>1.19</u>	<u>0.66</u>	0	1.5	394	193	a	a
20	<u>1.19</u>	<u>0.66</u>	0	1.5	406	217	a	a
21	<u>1.19</u>	<u>0.66</u>	0	1.5	446	247	a	a
22	<u>1.98</u>	<u>1.10</u>	0	1.5	443	336	a	a
23	<u>1.98</u>	<u>1.10</u>	0	1.5	518	381	a	a
24	<u>1.98</u>	<u>1.10</u>	0	1.5	496	428	a	a
25	<u>1.19</u>	<u>0.66</u>	0	1.8	422	209	a	a
26	<u>1.19</u>	<u>0.66</u>	0	1.8	511	235	a	a
27	<u>1.19</u>	<u>0.66</u>	0	1.8	528	268	a	a
28	<u>1.98</u>	<u>1.10</u>	0	1.8	577	381	a	a
29	<u>1.98</u>	<u>1.10</u>	0	1.8	538	432	a	a
30	<u>1.98</u>	<u>1.10</u>	0	1.8	581	485	a	a
31	<u>1.19</u>	<u>0.66</u>	0	2.1	414	225	a	a
32	<u>1.19</u>	<u>0.66</u>	0	2.1	535	254	a	a
33	<u>1.19</u>	<u>0.66</u>	0	2.1	523	288	a	a
34	<u>1.98</u>	<u>1.10</u>	0	2.1	620	425	a	a
35	<u>1.98</u>	<u>1.10</u>	0	2.1	650	483	a	a
36	<u>1.98</u>	<u>1.10</u>	0	2.1	747	542	a	a

[continued]

# Report 69 [continued]

Date : 1972, May  
 Title : Terrain coefficients for energy cost prediction  
 Author(s): Soule and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Field and Treadmill  
 Subjects : 8 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
37	Blacktop - 2.5 mph - 8kg backpack	6	74	b	8	11
38	Blacktop - 2.5 mph - 30kg backpack	6	74	b	30	41
39	Blacktop - 3.5 mph - 8kg backpack	6	74	b	8	11
40	Blacktop - 3.5 mph - 30kg backpack	6	74	b	30	41
41	Treadmill - 2.5 mph - 8kg backpack	6	74	b	8	11
42	Treadmill - 2.5 mph - 30kg backpack	6	74	b	30	41
43	Treadmill - 3.5 mph - 8kg backpack	6	74	b	8	11
44	Treadmill - 3.5 mph - 30kg backpack	4 <sup>c</sup>	74	b	30	41

<sup>a</sup>Data not collected.

<sup>b</sup>Included in load weight.

<sup>c</sup>Mean weight for 6 subjects.

Report 69

<u>Line No.</u>	<u>Dist. (km)</u>	<u>Speed (mps)</u>	<u>Grade (%)</u>	<u>Footing Factor</u>	<u>Energy (Watts)</u>		<u>Heart Rate</u>	<u>VO<sub>2</sub> (L/Min)</u>
					<u>Obs.</u>	<u>Pred.</u>		
37	<u>1.98</u>	<u>1.10</u>	0	1.0	263	262	a	a
38	<u>1.98</u>	<u>1.10</u>	0	1.0	314	334	a	a
39	<u>2.79</u>	<u>1.55</u>	0	1.0	382	408	a	a
40	<u>2.79</u>	<u>1.55</u>	0	1.0	467	520	a	a
41	<u>1.98</u>	<u>1.10</u>	0	1.0	277	262	a	a
42	<u>1.98</u>	<u>1.10</u>	0	1.0	346	334	a	a
43	<u>2.79</u>	<u>1.55</u>	0	1.0	380	408	a	a
44	<u>2.79</u>	<u>1.55</u>	0	1.0	487	520	a	a

[concluded]

# Report 70

Date : 1972, August  
 Title : Pacing of intermittent work during 31 hours  
 Author(s): Soule and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 10 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	15 kg pack - exper. hour 1	6	75 <sup>b</sup>	4 <sup>c</sup>	15	25
2	" - " 7	6	75 <sup>b</sup>	4 <sup>c</sup>	15	25
3	" - " 13	6	75 <sup>b</sup>	4 <sup>c</sup>	15	25
4	" - " 19	6	75 <sup>b</sup>	4 <sup>c</sup>	15	25
5	" - " 25	6	75 <sup>b</sup>	4 <sup>c</sup>	15	25
6	" - " 31	6	75 <sup>b</sup>	4 <sup>c</sup>	15	25
7	30 kg pack - " 1	6	75 <sup>b</sup>	4 <sup>c</sup>	30	45
8	" - " 7	6	75 <sup>b</sup>	4 <sup>c</sup>	30	45
9	" - " 13	6	75 <sup>b</sup>	4 <sup>c</sup>	30	45
10	" - " 19	6	75 <sup>b</sup>	4 <sup>c</sup>	30	45
11	" - " 25	6	75 <sup>b</sup>	4 <sup>c</sup>	30	45
12	" - " 31	6	75 <sup>b</sup>	4 <sup>c</sup>	30	45

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for entire subject pool.

<sup>c</sup>Estimated from textual details.

<sup>d</sup>Not all subjects completed the distance in the required hour.



# Report 70

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Perceived Exertion
					Obs.	Pred.			
1	4.80 <sup>d</sup>	1.58	0	1.0	a	477	105	a	10.7
2	4.80 <sup>d</sup>	1.64	0	1.0	a	504	111	a	10.7
3	4.80 <sup>d</sup>	1.65	0	1.0	a	508	99	a	11.5
4	4.80 <sup>d</sup>	1.52	0	1.0	a	450	103	a	12.0
5	4.80 <sup>d</sup>	1.45	0	1.0	a	421	101	a	12.7
6	4.80 <sup>d</sup>	1.54	0	1.0	a	459	106	a	13.3
7	4.80 <sup>d</sup>	1.39	0	1.0	a	473	107	a	14.4
8	4.80 <sup>d</sup>	1.48	0	1.0	a	515	119	a	14.6
9	4.80 <sup>d</sup>	1.47	0	1.0	a	511	103	a	14.8
10	4.80 <sup>d</sup>	1.39	0	1.0	a	473	114	a	15.0
11	4.80 <sup>d</sup>	1.37	0	1.0	a	464	113	a	16.8
12	4.80 <sup>d</sup>	1.40	0	1.0	a	478	112	a	17.0

# Report 71

Date : 1977, May  
 Title : Energy expenditure of heavy load carriage  
 Author(s): Soule, Pandolf, and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 24 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load - slow	14	72	3 <sup>b</sup>	0	4
2	" - " - medium	14	72	3 <sup>b</sup>	0	4
3	" - " - fast	14	72	3 <sup>b</sup>	0	4
4	30kg belt - 5kg vest - slow	14	72	3 <sup>b</sup>	35	53
5	" - " - medium	14	72	3 <sup>b</sup>	35	53
6	" - " - fast	14	72	3 <sup>b</sup>	35	53
7	" - 10kg vest - slow	14	72	3 <sup>b</sup>	40	60
8	" - " - medium	14	72	3 <sup>b</sup>	40	60
9	" - " - fast	14	72	3 <sup>b</sup>	40	60
10	" - 15kg vest - slow	14	72	3 <sup>b</sup>	45	67
11	" - " - medium	14	72	3 <sup>b</sup>	45	67
12	" - " - fast	14	72	3 <sup>b</sup>	45	67
13	" - 20kg vest - slow	14	72	3 <sup>b</sup>	50	74
14	" - " - medium	14	72	3 <sup>b</sup>	50	74
15	" - " - fast	14	72	3 <sup>b</sup>	50	74
16	Control - no load - slow	10	75	3 <sup>b</sup>	0	4
17	" - " - medium	10	75	3 <sup>b</sup>	0	4
18	" - " - fast	10	75	3 <sup>b</sup>	0	4
19	35kg belt - 25kg vest - slow	10	75	3 <sup>b</sup>	60	84
20	" - " - medium	10	75	3 <sup>b</sup>	60	84
21	" - " - fast	10	75	3 <sup>b</sup>	60	84
22	" - 30kg vest - slow	10	75	3 <sup>b</sup>	65	91
23	" - " - medium	10	75	3 <sup>b</sup>	65	91
24	" - " - fast	10	75	3 <sup>b</sup>	65	91
25	" - 35kg vest - slow	10	75	3 <sup>b</sup>	70	97
26	" - " - medium	10	75	3 <sup>b</sup>	70	97
27	" - " - fast	10	75	3 <sup>b</sup>	70	97

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Not all subjects could walk for the full 45 minutes.

# Report 71

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	1.07	0.89	0	1.0	a	197	a	0.65
2	1.60	1.33	0	1.0	a	307	a	0.90
3	2.14	1.78	0	1.0	a	465	a	1.33
4	1.07	0.89	0	1.0	a	300	a	1.16
5	1.60	1.33	0	1.0	a	461	a	1.55
6	2.14	1.78	0	1.0	a	692	a	2.46
7	1.07	0.89	0	1.0	a	327	a	1.17
8	1.60	1.33	0	1.0	a	495	a	1.69
9	2.14	1.78	0	1.0	a	737	a	2.51
10	1.07	0.89	0	1.0	a	357	a	1.16
11	1.60	1.33	0	1.0	a	533	a	1.73
12	2.14	1.78	0	1.0	a	785	a	2.63
13	1.07	0.89	0	1.0	a	392	a	1.31
14	1.60	1.33	0	1.0	a	575	a	1.84
15	2.14	1.78	0	1.0	a	838	a	2.80
16	2.40	0.89	0	1.0	a	205	a	0.79
17	3.59	1.33	0	1.0	a	320	a	1.05
18	4.81	1.78	0	1.0	a	483	a	1.54
19	0.99 <sup>c</sup>	0.89	0	1.0	a	471	a	1.35
20	1.48 <sup>c</sup>	1.33	0	1.0	a	673	a	1.93
21	1.98 <sup>c</sup>	1.78	0	1.0	a	963	a	3.05
22	0.83 <sup>c</sup>	0.89	0	1.0	a	518	a	1.40
23	1.24 <sup>c</sup>	1.33	0	1.0	a	727	a	2.04
24	1.66 <sup>c</sup>	1.78	0	1.0	a	1027	a	3.07
25	0.44 <sup>c</sup>	0.89	0	1.0	a	569	a	1.54
26	0.66 <sup>c</sup>	1.33	0	1.0	a	786	a	2.06
27	0.89 <sup>c</sup>	1.78	0	1.0	a	1096	a	3.12

# Report 72

Date : 1978  
 Title : Voluntary march rate as a measure of work output in the heat  
 Author(s): Soule, Pandolf, and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 13 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	40°C - 25% r.h. - 18 kg pack	5	73 <sup>b</sup>	2 <sup>c</sup>	18	27
2	" - 35% r.h. - 10 kg pack	7	77	2 <sup>c</sup>	10	16
3	" - 50% r.h. - 10 kg pack	7	77	2 <sup>c</sup>	10	16
4	" - 50% r.h. - 18 kg pack	4	73 <sup>b</sup>	2 <sup>c</sup>	18	27
5	" - 65% r.h. - 10 kg pack	7	77	2 <sup>c</sup>	10	16
6	" 75% r.h. - 18 kg pack	6	73	2 <sup>c</sup>	18	27

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for subset of 6 subjects.

<sup>c</sup>Estimated from textual details.

<sup>d</sup>Not all subjects were able to complete the 8 km march.

<sup>e</sup>N=3.

<sup>f</sup>N=4.

# Report 73

Date : 1966, June  
 Title : Effects of load-carrying on psychomotor performance  
 Author(s): Strauss and Carlock  
 Lab : Picatinny Arsenal, Dover, NJ  
 Type : Field  
 Subjects : 10 male students

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	14 lb belt load	10	a	2 <sup>b</sup>	6	a
2	14 lb belt load - two 10 lb ammo cans	10	a	2 <sup>b</sup>	15	a
3	14 lb belt load - 20 lb rucksack	10	a	2 <sup>b</sup>	15	a

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Course described as hilly.

# Report 72

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Rectal Temp. °C
					Obs.	Pred.			
1	<u>8.00</u>	1.59	0	1.0	a	476	a	1.19	38.4 <sup>e</sup>
2	<u>8.00</u>	1.59	0	1.0	a	457	a	1.28	37.9
3	<u>8.00</u>	1.56	0	1.0	a	445	a	1.15	38.8
4	<u>8.00</u>	1.26	0	1.0	a	345	a	1.00	38.5 <sup>e</sup>
5	<u>4.80</u> <sup>d</sup>	1.40	0	1.0	a	381	a	1.09	39.1 <sup>f</sup>
6	<u>3.20</u> <sup>d</sup>	1.25	0	1.0	a	341	a	1.00	38.8 <sup>f</sup>

# Report 73

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>3.22</u>	<u>3.62</u>	0 <sup>c</sup>	1.2	a	a	a	a
2	<u>3.22</u>	<u>3.56</u>	0 <sup>c</sup>	1.2	a	a	a	a
3	<u>3.22</u>	<u>3.47</u>	0 <sup>c</sup>	1.2	a	a	a	a

# Report 74

Date : 1957, October  
 Title : Evaluation of Army combat packs by measuring energy costs and speed  
 Author(s): Tan, Hale, and Karpovich  
 Lab : Quartermaster Research and Engineering Center  
 Type : Field  
 Subjects : 10 male students

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	10	75	3 <sup>b</sup>	0	4
2	27 lb US standard pack	10	75	3 <sup>b</sup>	12	20
3	" T53-8 pack	10	75	3 <sup>b</sup>	12	20
4	" UK-Z2 pack	10	75	3 <sup>b</sup>	12	20

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>These data indicate the total volume of oxygen consumed in liters. Whether the authors were expressing these figures in liters per minute is unclear.

# Report 75

Date : 1972  
 Title : Increased energy cost with multiple clothing layers  
 Author(s): Teitlebaum and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 8 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	5.6 km/hr - arctic uniform	8	72	14	0	19
2	5.6 km/hr - weighted belt and pouches	8	72	3	11	19
3	8.0 km/hr - arctic uniform	8	72	14	0	19
4	8.0 km/hr - weighted belt and pouches	8	72	3	11	19

<sup>a</sup>Data not collected.



Report 74

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>0.02</u>	5.34	0	1.1	a	3783	a	1.62 <sup>c</sup>
2	<u>0.02</u>	4.81	0	1.1	a	3555	a	2.01 <sup>c</sup>
3	<u>0.02</u>	4.86	0	1.1	a	3627	a	1.94 <sup>c</sup>
4	<u>0.02</u>	4.74	0	1.1	a	3456	a	2.03 <sup>c</sup>

Report 75

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.87</u>	<u>1.56</u>	0	1.0	514	428	a	a
2	<u>1.87</u>	<u>1.56</u>	0	1.0	435	428	a	a
3	<u>2.67</u>	<u>2.22</u>	0	1.0	995	750	a	a
4	<u>2.67</u>	<u>2.22</u>	0	1.0	873	750	a	a

# Report 76

Date : 1973, October  
 Title : The effects of weight and length on the portability of antitank  
 weapon systems...  
 Author(s): Torre  
 Lab : US Army Human Engineering Laboratory  
 Type : Field  
 Subjects : 28 airborne infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	LAW tube - slung, bandoleer - style	28	73 <sup>b</sup>	6	13	26
2	25", 8 lb tube - slung	28	73 <sup>b</sup>	6	14	27
3	" , 16 lb tube - slung	28	73 <sup>b</sup>	6	18	33
4	" , 24 lb tube - slung	28	73 <sup>b</sup>	6	21	37
5	31", 8 lb tube - slung	28	73 <sup>b</sup>	6	14	27
6	37", 8 lb tube - slung	28	73 <sup>b</sup>	6	14	27
7	" , 16 lb tube - slung	28	73 <sup>b</sup>	6	18	33
8	" , 24 lb tube - slung	28	73 <sup>b</sup>	6	21	37
9	43", 8 lb tube - slung	28	73 <sup>b</sup>	6	14	27
10	" , 24 lb tube - slung	28	73 <sup>b</sup>	6	21	37
11	Three 25", 8 lb tubes - slung	28	73 <sup>b</sup>	6	21	37
12	Three 31", 8 lb tubes - slung	28	73 <sup>b</sup>	6	21	37

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for US Army soldier (Ref. 131).

<sup>c</sup>All subjects completed the course, but no times were taken.

# Report 76

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>2.35</u>	c	0	1.3	a	a	a	a
2	<u>2.35</u>	c	0	1.3	a	a	a	a
3	<u>2.35</u>	c	0	1.3	a	a	a	a
4	<u>2.35</u>	c	0	1.3	a	a	a	a
5	<u>2.35</u>	c	0	1.3	a	a	a	a
6	<u>2.35</u>	c	0	1.3	a	a	a	a
7	<u>2.35</u>	c	0	1.3	a	a	a	a
8	<u>2.35</u>	c	0	1.3	a	a	a	a
9	<u>2.35</u>	c	0	1.3	a	a	a	a
10	<u>2.35</u>	c	0	1.3	a	a	a	a
11	<u>2.35</u>	c	0	1.3	a	a	a	a
12	<u>2.35</u>	c	0	1.3	a	a	a	a

# Report 77

Date : 1952, May  
 Title : Means of carrying individual equipment  
 Author(s): US Army Field Forces Board  
 Lab : No information available  
 Type : Field  
 Subjects : No information available

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	35 lb packboard	a	73 <sup>c</sup>	a	16	a
2	55 lb packboard	a	73 <sup>c</sup>	a	25	a
3	Experimental backpack	a	73 <sup>c</sup>	a	21	a
4	" low-backpack	a	73 <sup>c</sup>	a	21	a

<sup>a</sup>Data not collected.

<sup>b</sup>The data from this study obtained from Ref. 108.

<sup>c</sup>Mean weight for US Army soldiers, Ref. 131.

# Report 78

Date : 1956, January  
 Title : Simulated sled-pulling on the treadmill  
 Author(s): Vanderbie  
 Lab : Quartermaster Research and Development Center, US Army  
 Type : Treadmill  
 Subjects : 12 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	11	68	3 <sup>b</sup>	0	4
2	44 lb pack	11	68	3 <sup>b</sup>	20	34
3	Simulated sled (17.5 lb drag), (2.5 mph)	11	68	3 <sup>b</sup>	8	16
4	Simulated sled (17.5 lb drag), (2.5 mph)	5	71	3 <sup>b</sup>	8	16
5	Simulated sled (17.5 lb drag), (2.5 mph)	5	71	3 <sup>b</sup>	8	16
6	Simulated sled with arctic clothing	5	71	12 <sup>b</sup>	8	28

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

# Report 77

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>28.97</u>	a	a	a	a	a	a	a
2	<u>11.27</u>	a	a	a	a	a	a	a
3	<u>88.51</u>	a	a	a	a	a	a	a
4	<u>88.51</u>	a	a	a	a	a	a	a

# Report 78

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Sweat Loss (g) /30 Min
					Obs.	Pred.			
1	a	<u>1.56</u>	0	1.0	377	361	113	a	142
2	a	<u>1.56</u>	0	1.0	443	455	124	a	229
3	a	<u>1.12</u>	0	1.0	555	255	136	a	230
4	a	<u>1.12</u>	0	1.0	517	265	a	a	a
5	a	<u>1.56</u>	0	1.0	715	410	a	a	a
6	a	<u>1.56</u>	0	1.0	779	453	a	a	a

# Report 79

Date : 1953, June  
 Title : Some experimental load distributions studied on the treadmill  
 Author(s): Vanderbie  
 Lab : Quartermaster Climatic Research Laboratory  
 Type : Treadmill  
 Subjects : 8 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	15 lb load in saddle bags around waist	8	76	3 <sup>b</sup>	7	13
2	15 lb in life preserver around neck	8	76	3 <sup>b</sup>	7	13
3	15 lb in cargo pockets on thighs	8	76	3 <sup>b</sup>	7	13
4	45 lb load in saddle bags	8	76	3 <sup>b</sup>	20	30
5	" in life preserver	8	76	3 <sup>b</sup>	20	30
6	" high on packboard	8	76	3 <sup>b</sup>	20	30
7	" low on packboard	8	76	3 <sup>b</sup>	20	30
8	" on 14 ft. shoulder-pole	8	76	3 <sup>b</sup>	20	30
9	Control - no load	8	76	3 <sup>b</sup>	0	4

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.



# Report 79

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>2.82</u>	<u>1.56</u>	0	1.0	427	431	119	a
2	<u>2.82</u>	<u>1.56</u>	0	1.0	403	431	116	a
3	<u>2.82</u>	<u>1.56</u>	0	1.0	444	431	121	a
4	<u>2.82</u>	<u>1.56</u>	0	1.0	497	494	130	a
5	<u>2.82</u>	<u>1.56</u>	0	1.0	455	494	121	a
6	<u>2.82</u>	<u>1.56</u>	0	1.0	451	494	121	a
7	<u>2.82</u>	<u>1.56</u>	0	1.0	440	494	121	a
8	<u>2.82</u>	<u>1.56</u>	0	1.0	551	494	130	a
9	<u>2.82</u>	<u>1.56</u>	0	1.0	350	403	110	a

# Report 80

Date : 1973, May  
 Title : An equation for prediction of energy expenditure of walking and running  
 Author(s): van der Walt and Wyndham  
 Lab : Human Sciences Laboratory, Chamber of Mines of South Africa  
 Type : Treadmill  
 Subjects : 6 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Walking - 3.2 km/hr	6	75 <sup>b</sup>	2 <sup>b</sup>	0	2
2	" - 4.8 km/hr	6	75 <sup>b</sup>	2 <sup>b</sup>	0	2
3	" - 6.4 km/hr	6	75 <sup>b</sup>	2 <sup>b</sup>	0	2
4	" - 8.0 km/hr	6	75 <sup>b</sup>	2 <sup>b</sup>	0	2
5	Running - 8.0 km/hr	6	75 <sup>b</sup>	2 <sup>b</sup>	0	2
6	" - 9.7 km/hr	6	75 <sup>b</sup>	2 <sup>b</sup>	0	2
7	" - 11.3 km/hr	6	75 <sup>b</sup>	2 <sup>b</sup>	0	2
8	" - 12.9 km/hr	6	75 <sup>b</sup>	2	0	2

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated clothing weight of 2 kg subtracted from reported subject weights.

<sup>c</sup>Data derived from equations for walking and running given in report.

Report 80

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	0.27	0.89	0	1.0	a	204	a	0.74 <sup>c</sup>
2	0.40	1.33	0	1.0	a	317	a	1.09 <sup>c</sup>
3	0.53	1.78	0	1.0	a	479	a	1.59 <sup>c</sup>
4	0.67	2.22	0	1.0	a	682	a	2.23 <sup>c</sup>
5	0.67	2.22	0	1.0	a	682	a	2.62 <sup>c</sup>
6	0.81	2.69	0	1.0	a	948	a	2.88 <sup>c</sup>
7	0.94	3.14	0	1.0	a	1251	a	3.18 <sup>c</sup>
8	1.08	3.58	0	1.0	a	1593	a	3.53 <sup>c</sup>

# Report 81

Date : 1974, September  
 Title : Man-packing a typical load over a standard jungle course...  
 Author(s): Williamson and Kindick  
 Lab : US Army Tropic Test Center  
 Type : Field  
 Subjects : 100 infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Normal march - dry season	15 <sup>b</sup>	73	6	8	19
2	Normal march - wet season	5 <sup>b</sup>	69	6	8	20
3	Forced march - dry season	15 <sup>b</sup>	73	6	8	19
4	Forced march - wet season	5 <sup>b</sup>	69	6	8	20
5	Uphill run - dry season	74	73	6	8	19
6	Uphill run - wet season	26	69	6	8	20
7	Double time - dry season	74	73	6	8	19
8	Double time - wet season	26	69	6	8	20

<sup>a</sup>Data not collected.

<sup>b</sup>Number of 5-man groups (event was group-timed).

<sup>c</sup>Climb described as "up a steep slope through mud and vines."

Report 81

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>2.26</u>	0.80	0	1.5	a	241	a	a
2	<u>2.26</u>	0.64	0	1.5	a	187	a	a
3	<u>1.59</u>	1.04	0	1.5	a	328	a	a
4	<u>1.59</u>	0.83	0	1.5	a	239	a	a
5	<u>0.09</u>	1.43	20 <sup>c</sup>	1.5	a	1822	a	a
6	<u>0.09</u>	1.19	20 <sup>c</sup>	1.5	a	1412	a	a
7	<u>0.06</u>	2.19	0	1.2	a	1055	a	a
8	<u>0.06</u>	1.97	0	1.2	a	835	a	a

# Report 82

Date : 1975, November  
 Title : A pilot study on load-carrying test methodology  
 Author(s): Williamson and Kindick  
 Lab : US Army Tropic Test Center  
 Type : Field  
 Subjects : 43 infantrymen

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Normal march - basic load	43	74	6	8	19
2	Normal march - 10 lbs extra on belt	43	74	6	13	25
3	Normal march - 20 lbs extra on belt	43	74	6	17	31
4	Normal march - 30 lbs extra on belt	43	74	6	22	37
5	Forced march - basic load	43	74	6	8	19
6	Forced march - 10 lbs extra on belt	43	74	6	13	25
7	Forced march - 20 lbs extra on belt	43	74	6	17	31
8	Forced march - 30 lbs extra on belt	43	74	6	22	37
9	Uphill run - basic load	43	74	6	8	19
10	Uphill run - 10 lbs extra on belt	43	74	6	13	25
11	Uphill run - 20 lbs extra on belt	43	74	6	17	31
12	Uphill run - 30 lbs extra on belt	43	74	6	22	37
13	Double time - basic load	43	74	6	8	19
14	Double time - 10 lbs extra on belt	43	74	6	13	25
15	Double time - 20 lbs extra on belt	43	74	6	17	31
16	Double time - 30 lbs extra on belt	43	74	6	22	37

<sup>a</sup>Data not collected.

<sup>b</sup>Climb described as "up a steep slope."

Report 82

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>2.26</u>	1.10	0	1.5	a	357	a	a
2	<u>2.26</u>	0.97	0	1.5	a	320	a	a
3	<u>2.26</u>	0.87	0	1.5	a	295	a	a
4	<u>2.26</u>	0.79	0	1.5	a	283	a	a
5	<u>1.59</u>	1.02	0	1.5	a	323	a	a
6	<u>1.59</u>	1.05	0	1.5	a	354	a	a
7	<u>1.59</u>	0.85	0	1.5	a	287	a	a
8	<u>1.59</u>	1.02	0	1.5	a	379	a	a
9	<u>0.09</u>	1.69	20 <sup>b</sup>	1.5	a	2244	a	a
10	<u>0.09</u>	1.63	20 <sup>b</sup>	1.5	a	2271	a	a
11	<u>0.09</u>	1.41	20 <sup>b</sup>	1.5	a	2000	a	a
12	<u>0.09</u>	1.26	20 <sup>b</sup>	1.5	a	1854	a	a
13	<u>0.06</u>	2.14	0	1.2	a	1024	a	a
14	<u>0.06</u>	2.49	0	1.2	a	1421	a	a
15	<u>0.06</u>	2.12	0	1.2	a	1111	a	a
16	<u>0.06</u>	1.80	0	1.2	a	884	a	a



# Report 83

Date : 1956, May  
 Title : Pack carrying in the desert  
 Author(s): Winsmann and Daniels  
 Lab : Quartermaster Research and Development Center, US Army  
 Type : Field and treadmill  
 Subjects : 13 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Control - no load	5	73	3 <sup>b</sup>	0	4
2	25 lb pack	5	73	3 <sup>b</sup>	11	19
3	40 lb pack	5	73	3 <sup>b</sup>	18	29
4	Control - no load	4	71	3 <sup>b</sup>	0	4
5	8 lb armored vest	4	71	3 <sup>b</sup>	4	10
6	32 lb pack w/armored vest	4	71	3 <sup>b</sup>	18	30
7	Control - no load (level, loose sand)	4	74	3 <sup>b</sup>	0	4
8	25 lb pack (level, loose sand)	4	74	3 <sup>b</sup>	11	19
9	30 " " " " "	4	74	3 <sup>b</sup>	14	22
10	40 " " " " "	4	74	3 <sup>b</sup>	18	28
11	Control - no load (level, hard road)	4	74	3 <sup>b</sup>	0	4
12	25 lb pack (level, hard road)	4	74	3 <sup>b</sup>	11	19
13	30 " " " " "	4	74	3 <sup>b</sup>	14	22
14	40 " " " " "	4	74	3 <sup>b</sup>	18	28
15	Control - no load (uphill, sand)	4	74	3 <sup>b</sup>	0	4
16	25 lb pack (uphill, sand)	4	74	3 <sup>b</sup>	11	19
17	30 " " " "	4	74	3 <sup>b</sup>	14	22
18	40 " " " "	4	74	3 <sup>b</sup>	18	28
19	Control - no load (downhill, sand)	4	74	3 <sup>b</sup>	0	4
20	25 lb pack (downhill, sand)	4	74	3 <sup>b</sup>	11	19
21	30 " " " "	4	74	3 <sup>b</sup>	14	22
22	40 " " " "	4	74	3 <sup>b</sup>	18	28
23	Treadmill control - no load	3	74	3 <sup>b</sup>	0	4
24	" 25 lb pack	3	74	3 <sup>b</sup>	11	19
25	" 40 " "	3	74	3 <sup>b</sup>	18	28

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Mean grade; grades ranged from about -2% to about +2%.

<sup>d</sup>Estimated from textual details (course was about 58% loose sand and 42% semi-pavement).

<sup>e</sup>Speed varied from 2 to 2.5 mph (0.89 to 1.12 mps).

# Report 83

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Rectal Temp. (°C)
					Obs.	Pred.			
1	2.32	1.29	0 <sup>c</sup>	1.7 <sup>d</sup>	487	432	126	a	37.7
2	2.32	1.29	0 <sup>c</sup>	1.7 <sup>d</sup>	550	485	141	a	38.4
3	2.32	1.29	0 <sup>c</sup>	1.7 <sup>d</sup>	620	524	157	a	38.6
4	2.32	1.29	0 <sup>c</sup>	1.7 <sup>d</sup>	458	421	122	a	38.1
5	2.32	1.29	0 <sup>c</sup>	1.7 <sup>d</sup>	578	439	137	a	38.2
6	2.32	1.29	0 <sup>c</sup>	1.7 <sup>d</sup>	580	513	153	a	38.6
7	2.01	1.12	0	2.1	466	416	127	a	38.2
8	2.01	1.12	0	2.1	533	465	139	a	38.4
9	2.01	1.12	0	2.1	546	480	146	a	38.6
10	2.01	1.12	0	2.1	593	502	160	a	38.1
11	2.01	1.12	0	1.0	319	256	101	a	37.8
12	2.01	1.12	0	1.0	342	283	108	a	37.8
13	2.01	1.12	0	1.0	355	292	113	a	37.9
14	2.01	1.12	0	1.0	365	305	129	a	37.9
15	2.01	1.01 <sup>e</sup>	30 <sup>b</sup>	2.1	622	2074	a	a	a
16	2.01	1.01 <sup>e</sup>	30 <sup>b</sup>	2.1	732	2360	a	a	a
17	2.01	1.01 <sup>e</sup>	30 <sup>b</sup>	2.1	704	2440	a	a	a
18	2.01	1.01 <sup>e</sup>	30 <sup>b</sup>	2.1	761	2547	a	a	a
19	2.01	1.12	-30 <sup>b</sup>	2.1	409	a	a	a	a
20	2.01	1.12	-30 <sup>b</sup>	2.1	451	a	a	a	a
21	2.01	1.12	-30 <sup>b</sup>	2.1	475	a	a	a	a
22	2.01	1.12	-30 <sup>b</sup>	2.1	509	a	a	a	a
23	a	1.12	0	1.0	291	256	a	a	a
24	a	1.12	0	1.0	320	283	a	a	a
25	a	1.12	0	1.0	333	305	a	a	a

# Report 84

Date : 1976, October  
 Title : Methods for evaluation of load-carriage systems  
 Author(s): Winsmann and Goldman  
 Lab : US Army Research Institute of Environmental Medicine  
 Type : Treadmill  
 Subjects : 33 male soldiers

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	5.6 km/hr - level - standard pack	9	73	3	30	45
2	" - " - hip pack	9	73	3	30	45
3	" - 5% grade - standard pack	2	73 <sup>b</sup>	3	30	45
4	5.6 km/hr - 5% grade - hip pack	2	73 <sup>b</sup>	3	30	45
5	8 km/hr - level - standard pack	9	73	3	30	45
6	" - " - hip pack	9	73	3	30	45
7	Self-paced - standard pack	8	76	3	30	44
8	" - hip pack	8	76	3	30	44
9	130 beats/min - standard pack	8	77	3	30	43
10	" - hip pack	8	77	3	30	43
11	160 beats/min - 6% grade - standard pack	6	76	3	30	44
12	160 beats/min - 6% grade - hip pack	7	78	3	30	42

<sup>a</sup>Data not collected.

<sup>b</sup>Mean weight for all 9 subjects in subtest.

Report 84

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)
					Obs.	Pred.		
1	<u>1.87</u>	<u>1.56</u>	0	1.0	599	540	a	a
2	<u>1.87</u>	<u>1.56</u>	0	1.0	602	540	a	a
3	<u>1.87</u>	<u>1.56</u>	5	1.0	893	829	a	a
4	<u>1.87</u>	<u>1.56</u>	5	1.0	894	829	a	a
5	<u>2.67</u>	<u>2.22</u>	0	1.0	1091	936	a	a
6	<u>2.67</u>	<u>2.22</u>	0	1.0	1080	936	a	a
7	<u>6.40</u>	<u>1.57</u>	0	1.0	647	558	a	a
8	<u>6.40</u>	1.64	0	1.0	665	595	a	a
9	<u>1.62</u>	1.35	0	1.0	a	457	<u>130</u>	a
10	1.70	1.42	0	1.0	a	489	<u>130</u>	a
11	1.47	1.23	6	1.0	a	684	<u>160</u>	a
12	1.54	1.28	6	1.0	a	728	<u>160</u>	a

# Report 85

Date : 1953, May  
 Title : Energy cost of wearing armored vests and carrying loads...  
 Author(s): Winsmann, Vanderbie, and Daniels  
 Lab : Quartermaster Climatic Research Laboratory  
 Type : Treadmill and field  
 Subjects : 7 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	Treadmill control - no load	6	70	3 <sup>b</sup>	0	4
2	Treadmill - w/8 lb vest	6	70	3 <sup>b</sup>	4	10
3	Treadmill - w/8 lb vest	6	70	3 <sup>b</sup>	4	10
4	Treadmill - w/8 lb pack	6	70	3 <sup>b</sup>	4	10
5	Treadmill - w/vest and 40 lb pack	7	69	3 <sup>b</sup>	22	36
6	Treadmill - w/40 lb pack	7	69	3 <sup>b</sup>	18	30
7	Treadmill - w/vest	4	64	3 <sup>b</sup>	4	11
8	Cinder Track - w/vest	4	64	3 <sup>b</sup>	4	11
9	3.5° slope control - no load	3	63	3 <sup>b</sup>	0	5
10	3.5° slope - vest	3	63	3 <sup>b</sup>	4	11
11	" - pack	3	63	3 <sup>b</sup>	18	33
12	" - pack and vest	3	63	3 <sup>b</sup>	22	40
13	6° slope control - no load	3	63	3 <sup>b</sup>	0	5
14	6° slope - vest	3	63	3 <sup>b</sup>	4	11
15	" - pack	3	63	3 <sup>b</sup>	18	33
16	" - pack and vest	3	63	3 <sup>b</sup>	22	40
17	17.5° slope control - no load	3	63	3 <sup>b</sup>	0	5
18	17.5° slope - vest	3	63	3 <sup>b</sup>	4	11
19	" - pack	3	63	3 <sup>b</sup>	18	33
20	" - pack and vest	3	63	3 <sup>b</sup>	22	40

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.

<sup>c</sup>Unpublished data showed high respiratory quotients "probably related to hyperventilation associated with severe exercise" for the 17.5° slope conditions.

# Report 85

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Sweat Loss (g)
					Obs.	Pred.			
1	2.82	1.56	0	1.0	373	372	a	1.12	a
2	2.82	1.56	0	1.0	395	388	a	1.19	a
3	2.82	1.56	0	1.0	387	388	a	1.16	a
4	2.82	1.56	0	1.0	385	388	a	1.15	a
5	2.82	1.56	0	1.0	441	471	124	1.33	253
6	2.82	1.56	0	1.0	433	449	122	1.30	205
7	a	1.56	0	1.0	372	357	a	1.11	a
8	a	1.56	0	1.1	410	383	a	1.22	a
9	0.37	1.65	6	1.2	571	693	a	a	a
10	0.37	1.59	6	1.2	586	695	a	a	a
11	0.37	1.56	6	1.2	614	811	a	a	a
12	0.37	1.51	6	1.2	592	818	a	a	a
13	0.27	1.59	11	1.2	680	880	a	a	a
14	0.27	1.60	11	1.2	716	936	a	a	a
15	0.27	1.46	11	1.2	684	1002	a	a	a
16	0.27	1.45	11	1.2	675	1045	a	a	a
17	0.18	1.39	32	1.2	1102 <sup>c</sup>	1557	a	a	a
18	0.18	1.27	32	1.2	1099 <sup>c</sup>	1494	a	a	a
19	0.18	1.09	32	1.2	968 <sup>c</sup>	1523	a	a	a
20	0.18	1.09	32	1.2	1014 <sup>c</sup>	1600	a	a	a

# Report 86

Date : 1963  
 Title : Oxygen cost of treadmill walking  
 Author(s): Workman and Armstrong  
 Lab : University of Maryland School of Medicine  
 Type : Treadmill  
 Subjects : 10 males

Line No.	Test Condition/Method of Carry	Subjects		Weight (kg)		%BW
		No.	W(kg)	Unif.	Load	
1	1.0 mph	10	76	2 <sup>b</sup>	0	3
2	1.5 mph	10	76	2 <sup>b</sup>	0	3
3	2.0 mph	10	76	2 <sup>b</sup>	0	3
4	2.5 mph	10	76	2 <sup>b</sup>	0	3
5	3.0 mph	10	76	2 <sup>b</sup>	0	3
6	3.5 mph	10	76	2 <sup>b</sup>	0	3
7	4.0 mph	10	76	2 <sup>b</sup>	0	3

<sup>a</sup>Data not collected.

<sup>b</sup>Estimated from textual details.



Report 86

Line No.	Dist. (km)	Speed (mps)	Grade (%)	Footing Factor	Energy (Watts)		Heart Rate	VO <sub>2</sub> (L/Min)	Step Freq. No./Min
					Obs.	Pred.			
1	<u>0.16</u>	<u>0.45</u>	0	1.0	a	138	a	0.63	57
2	<u>0.24</u>	<u>0.67</u>	0	1.0	a	167	a	0.71	75
3	<u>0.32</u>	<u>0.89</u>	0	1.0	a	207	a	0.77	87
4	<u>0.40</u>	<u>1.12</u>	0	1.0	a	261	a	0.86	98
5	<u>0.48</u>	<u>1.34</u>	0	1.0	a	324	a	1.02	107
6	<u>0.56</u>	<u>1.56</u>	0	1.0	a	399	a	1.18	115
7	<u>0.64</u>	<u>1.79</u>	0	1.0	a	489	a	1.48	121

## SUMMARY

The experimental conditions and results of 86 studies on portage and marching were gathered and displayed on a standard set of charts. The data in the charts were cross-indexed by type and range to allow researchers to identify easily particular conditions of portage. The data provided in this compendium should help to eliminate unneeded testing in the area of portability.

## REFERENCES

The references are grouped into three sections:

1. Section 1 contains the 86 abstracted reports.
2. Section 2 contains the remaining reports reviewed for this report. These reports were either of a general nature, or they contained no data that could be adapted to the compendium's standard format.
3. Section 3 contains those reports whose titles indicate a relationship to the topic of the compendium but they were not available for review. We hope to publish a supplement containing the data from many of these reports. Assistance in obtaining copies of these reports will be greatly appreciated.

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